NINTH ANNIVERSARY ISSUE

Metal Treating

THE ONLY MAGAZINE DEVOTED EXCLUSIVELY TO THE HEAT TREATING INDUSTRY

Photo Courtesy Lindberg Steel Treating Co.

SEPTEMBER-OCTOBER 1959

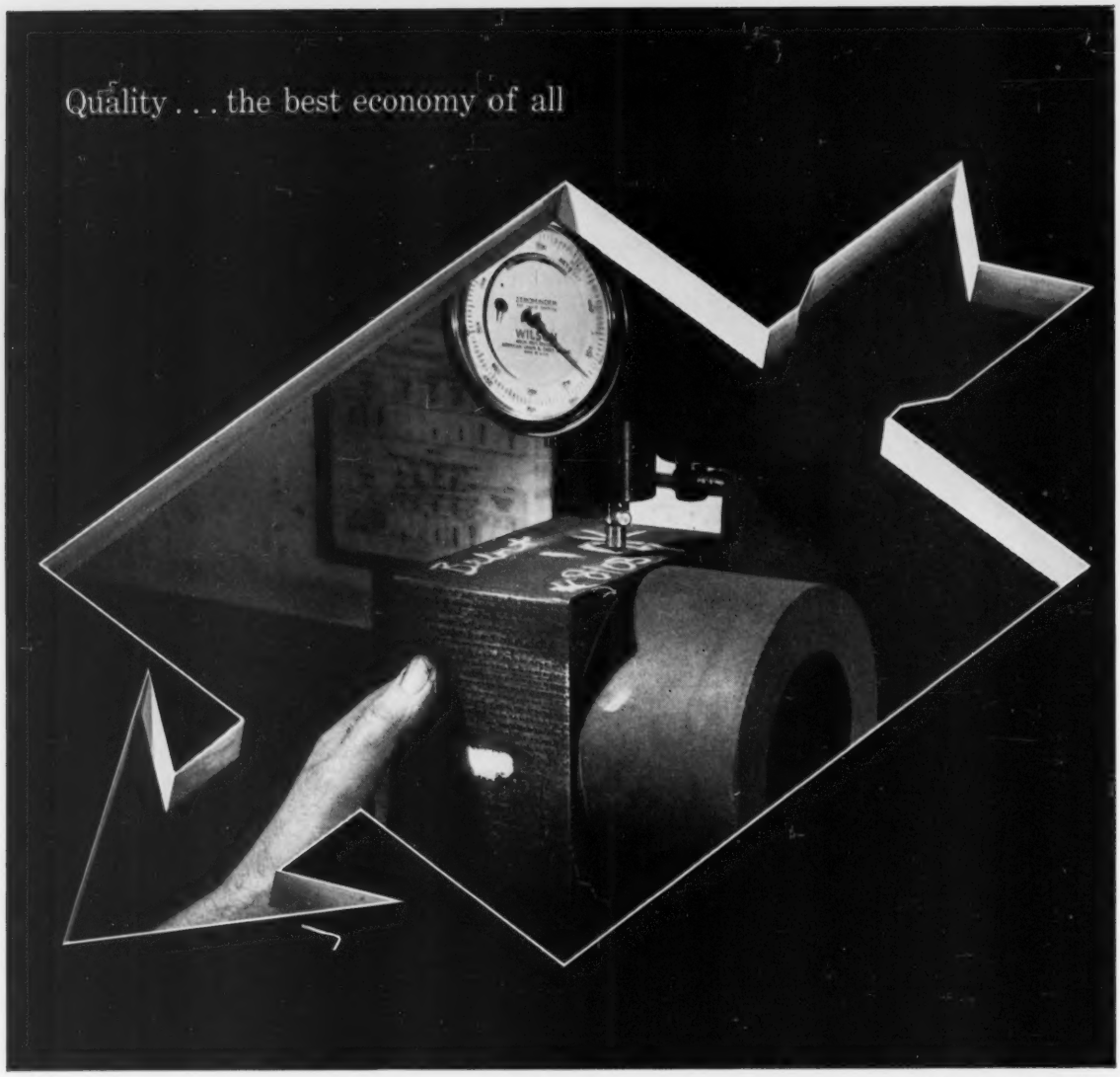


Photo courtesy of J. W. Rex Corp.

To hit the exact qualities you want . . . you need a choice of quenching oils

You can *get by* with just one quenching oil. But you can't always get the *best results* . . . not when you measure quality to a fine degree. Very often, you need a choice.

Sun makes quenching oils to reduce cooler-maintenance costs... oils with high antidecomposition qualities . . . oils for fast-quenching operations . . . oils for marquenching . . . and other "specials."

See your Sun representative for help in evaluating your quenching needs. He'll show you how to save money while maintaining quality . . . the best economy of all.

SUN OIL COMPANY, Philadelphia 3, Pa. Dept. MT-9.
In Canada: Sun Oil Company Limited, Toronto and Montreal.

SUNOCO®

MAKERS OF FAMOUS CUSTOM-BLENDED BLUE SUNOCO GASOLINES

For further information circle No. 74

Metal Treating

THE ONLY MAGAZINE DEVOTED EXCLUSIVELY TO THE HEAT TREATING INDUSTRY

Vol. X
SEPTEMBER-OCTOBER
No. 5

TABLE OF CONTENTS

ARTICLES

FEATURES

• • •

Indexed in Engineering Index

BPA

Member of Business Publications Audit of Circulation, Inc.

Published bimonthly by the Metal Treating Institute, 271 North Avenue, New Rochelle, N. Y. Phone: NE 6-4658.

Accepted as Controlled Circulation publication at New York, N. Y.

The Cover

A controlled atmosphere, bottom quench, gantry-type hardening furnace and associated tempering facilities installed in the heat treating plant of Lindberg Steel Treating Co., Melrose Park, Ill. For more details and pictures see pages 4-7.

Dip Brazing Technics In Electrically-Heated Salt Bath Furnaces

By **L. B. ROSSEAU**, President
Ajax Electric Company
Philadelphia, Pa.

Editor's Note: This article is based upon a talk delivered by the author on this subject at the International Congress on Electro-Heat this past May in Stresa, Italy.

THE JOINING of assemblies of various metals together by bonding them with a lower melting point alloy is an art that reaches back in history to antiquity. However, in the past 40 years it has been greatly expanding both in technics and in uses. The development parallels that of the use of electric heat in industry. Actually, it owes its popularity almost entirely to electric heating since controlled atmosphere electric furnaces were required before copper brazing could be adopted in industry. Likewise, induction heating opened many more fields of application where localized heating was satisfactory and desirable.

The electrode type salt bath furnace which became available in the 1930's introduced another type of electric heating to this process. It has steadily broadened its field of application and today, for some work, it is the most practical and, therefore, the most popular one. While no accurate statistics are available, it is known that the number of installations in the United States of electrode type furnaces for dip brazing is well in excess of 100 with a connected load of approximately 5000 kw.

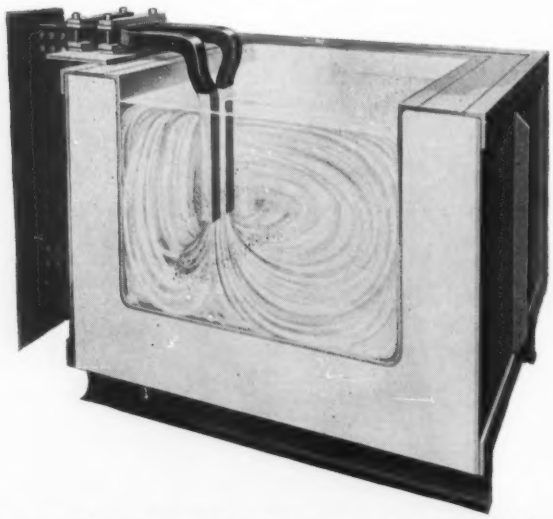


Fig. 1—Electrode type salt bath furnace with metallic pot showing closely spaced electrode construction.

Dip brazing are the words which have become associated with brazing by immersion in a fused salt bath furnace. It covers both those cases where the entire assembly is submerged below the surface of the bath and those where partial, or selective immersion only, is involved.

Characteristics of Molten Salts

As a heating device, a salt bath differs in many respects from an atmosphere furnace. A clear understanding of its inherent characteristics is required at this time. These are:

1) The rate of heating obtainable in a fused salt is roughly four times greater than that obtainable in a radiantly heated furnace and it is largely independent of the composition of the salt. This means that its capacity to produce per unit of volume is four times greater.

2) The uniformity of temperature within the working volume of an electrode salt bath is extremely good, generally well within 5° C. It is furthermore easy to control it automatically. There are no temperature requirements in brazing processes today that it cannot meet easily and simply.

3) It provides a sharp line of demarkation between the heated and unheated areas. Its temperature uniformity is unaffected by the use of a cover or door and, therefore, it is well suited to selective heating.

4) It eliminates the need of a controlled atmosphere by excluding contact with the air of the heated work both during the heating and during the cooling from the furnace.

5) By proper selection of the salt composition, it is often possible to combine the heating and fluxing of the work in a single step.

6) The weight of the work immersed is reduced, because of the buoyancy effect of the salt, by approximately 25%, and in some cases by as much as 60%. This may be a factor of considerable importance.

7) The work invariably requires a cleaning operation after the brazing treatment since it is coated with salt. However, since fluxes are soluble in the salt, flux removal presents no additional problem.

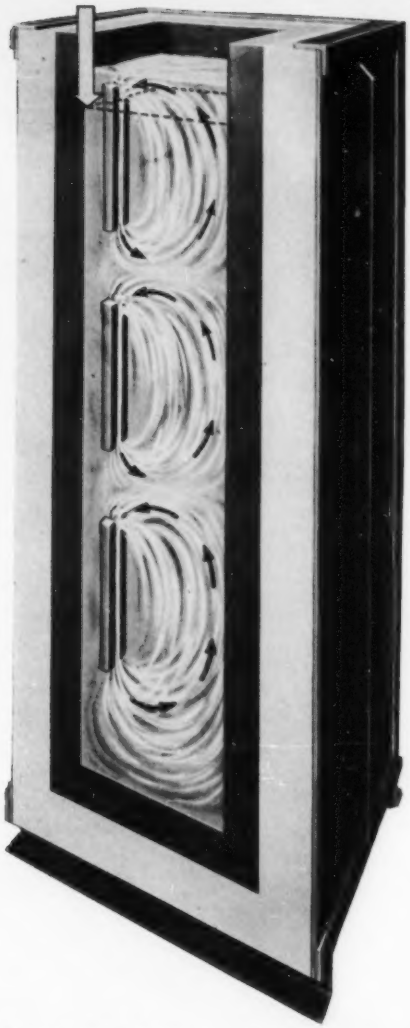


Fig. 2—Electrode type salt bath furnace with ceramic pot showing cascaded electrode and thermodynamic circulation attained through closely spaced electrode.

8) Because of the type of furnace used and the absence of an atmosphere, dip brazing is especially adaptable to the combination of hardening or of carburizing and hardening with brazing in a single unit.

9) The work must be dry or splatter will result. Its shape must not trap salt. It must sink readily. It should not have small blind holes. In other words, certain limitations must be met before dip brazing can be successfully used.

Types of Equipment

While it is possible to have a salt bath furnace heated by the combustion of fuel, practically every commercial installation uses electric heat, in the form of an electrode type furnace. This type of furnace makes use of the fact that molten salts are excellent resistors. Therefore, if the proper amount of current is passed through the salt, heat will be generated in the required amount. To accomplish this, alternating current potential is applied to the bath by means of metal bars or electrodes. All heat is generated internally (See Fig. 1). Therefore, the salt container or pot has only the single function of holding the salt. It need not be metallic, and, in fact, in a great majority of cases, is made up of ceramic bricks or tiles. These are generally unaffected by the salt and the operating temperature. The simplicity of this design and its very low cost of maintenance are responsible for its success and popularity.

Furthermore, by the proper disposition of these electrodes, an effective electromagnetic stirring or salt pumping effect is obtained (See Fig. 2). This is of importance not only because it assists in temperature uniformity, but because it removes any danger of decomposing the salt by localized overheating.

In addition to operating successfully, the electrode furnace must also do so at a cost which is competitive to other methods. This is especially true in the United States where the relation of cost per heat unit supplied by electric power to that supplied by natural fuels is much more favorable to the natural fuels than it is generally in Europe. When applied to dip brazing processes, the electrode furnace is generally preferred because of the following reasons:

1) High Efficiency. With well insulated walls and with no products of combustion, the heat losses can be kept very low. It is common to have a thermal efficiency, that is ratio of heat in the work to total heat supplied well in excess of 50% and in some instances as high as 65% when operating at 1520° F (800° C).

2) Long equipment life with low maintenance costs, due to the principle of internal heating, the use of proper alloys for electrodes and of ceramic pots.

3) The necessity of accurate temperature distribution throughout the furnace together with close control, generally plus or minus 5° C or less.

The result of these several factors is to permit an overall operating cost, using expensive electric energy at a cost averaging 2500 BTU's (heat units) per cent to be competitive with excellent and cheap fuels, such as natural gas, with a cost averaging 20,000 BTU per cent, or eight times less.

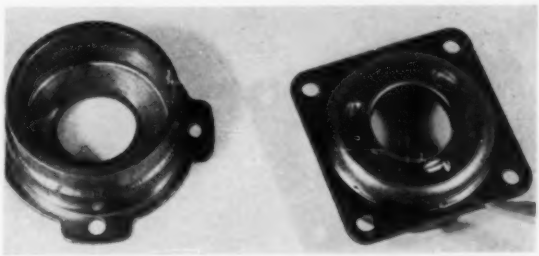


Fig. 3—Rotary solenoid switch parts brass brazed and carburized to .007" depth in one operation.

It must be recognized that dip brazing is a rather delicate operation and that there are other economic

(Continued on page 30)

INVERTED PIT FURNACES

Company (listed according to furnace size)	Heating Space Diameter	Heating Space Length	Description	No. of Furnaces	Source of Heat	Types of Atmospheres	Maximum Temperature (°
Aerojet-General Corp. Azusa, California	100"	21'	Gantry	1	Electric	Endothermic	2050
Army Ballistic Missile Agency Redstone Arsenal, Alabama	96"	10'	Bottom Opening	1	Electric	None (air)	1200
Lindberg Steel Treating Co. Melrose Park, Illinois	80"	24'	Bottom Opening Gantry	1	Electric	Endothermic, Nitrogen, Argon	2050
Thompson Ramo Wooldridge, Inc. Cleveland, Ohio	72"	22'	Bottom Opening Gantry	1	Electric	High Nitrogen or Argon	2050
Marquardt Aircraft Co. Van Nuys, California	72"	10'	Gantry	1	Electric	Endothermic	2000
J. W. Rex Company Landsdale, Pennsylvania	71"	22'	Bottom Opening Gantry	1	Electric	Endothermic	1950
Commercial Steel Treating Corp. Detroit, Michigan	70"	28'	Bottom Opening Gantry	1	Gas	Endothermic	1850
Goodyear Aircraft Corp. Akron, Ohio	68" 35"	21' 13'	Bottom Opening Gantry (All three)	1 2	Electric Gas	Nitrogen Endothermic	1950 1700
Metallurgical, Inc. Minneapolis, Minnesota	66"	22'	Bottom Opening	1	Electric	Any atmosphere required	2200
California-Doran Heat Treating Co. Los Angeles, California	60"	16'	Bottom Opening Gantry	1	Radiant Tube (Gas)	Endothermic, Exothermic, Nitrogen, Argon	1900
Boeing Airplane Company Seattle, Washington	60"	14'	Gantry	1	Electric	Endothermic	2050
Aerojet-General Corp. Azusa, California	55"	16'	Bottom Opening Gantry	1	Radiant Tube (Gas)	Endothermic or Exothermic	1800
Norris-Thermador Los Angeles, California	54"	11' 1"	Bottom Opening Gantry	1	Gas	Endothermic	1800
Alco Products Manufacturing Co. Dunkirk, New York	44"	13' 8"	Bottom Opening	1	Electric	Endothermic	1950
Pittsburgh Commercial Heat Treating Co. Pittsburgh, Pennsylvania	44"	10'	Bottom Opening	1	Electric	Endothermic	1900
Ingersoll Kalamazoo Division Borg-Warner Corp. Kalamazoo, Michigan	40"	8' 4"	Bottom Opening	1	Electric	Cracked Natural Gas	1800
Metlab Company Philadelphia, Pennsylvania	36"	14'	Bottom Opening	1	Propane Gas	Endothermic or Exothermic	1850

PIT FURNACES (TOP OPENING)

Solar Aircraft Company, San Diego, California	108"	30'	Pit	1	Electric	Endothermic, Nitrogen, Hydrogen, Argon	1950
California-Doran Heat Trtg. Co. Los Angeles, California	60"	6'	Pit	1	Gas	Endothermic or Exothermic	1900
A. O. Smith Milwaukee, Wisconsin	60" 54"	10' 12'	Pit Pit	1 1	Electric Electric	Inert and Recarb. Inert and Recarb.	1750 1750
Parish Pressed Steel Reading, Pennsylvania	30"	12'11"	Pit	1	Oil	Products of Combustion	1650
The Hicks Corporation Boston, Massachusetts	33"	16'	Salt Pot	2	Electric Gas	Neutral Salt Neutral Salt	1700
M. W. Kellogg Company Jersey City, New Jersey	30"	10'	Salt Pot	2 hi temp. 2 lo temp.	Electric	Neutral Salt	1700 1300

Tempering Facilities		Metallurgical Facilities
Size (Vertical)	Temperature °F	Magnaflux, X-Ray, Tensile and Hardness Testing
100" x 21'	1450	All
96" x 10'	1200	All
80" x 24'	1250	All
72" x 22'	1400	All plus supplementary analytical facilities and radiographic laboratory
72" x 10'	1000	All plus Spectrographic, Diffraction Unit (GE XRD5), Impact Tester, Krause Axial Fatigue, etc.
71" x 22' (2) 71" x 15' (1) 71" x 8' (1)	1500 1500 1500	All except X-ray
70" x 28'	1250	All except X-ray
3" x 20' 10" (2) 30" x 13' (6) 48" x 13' (2)	1400 1200 1700	All plus environmental test, stress and static test, and process development laboratories
84" x 24'	1250	All except tensile testing & X-ray
60" x 16'	1150	All
60" x 14'	1450	All
0" x 6' (Horiz.)	1200	All
60" x 16'	1300	All
2" x 4' x 20' (Horiz.) 48" x 13'8" (Vert.)	1350 1250	All plus ultrasonic testing
40" x 10'	1850	All except tensile testing
72" x 14'	1400	All
Available according to requirements		All
108" x 30'	1950	All plus ultrasonic testing
42" x 16'	1700	All
4" x 12' (2)	1350	All
x 6'8" x 23'4" (Horiz.)	1600	All
2" x 6' x 20' (Horiz.)	1300	All
" x 36" x 12' " x 36" x 6'	1300 1300	All plus Zyglo, ultrasonic testing, wet chemical, X-ray diffraction

Survey Of Special Furnaces For Rocket, Missile, And Aircraft Components

The increasing demand for special equipment capable of providing the essential and closely-controlled heat treatment of rocket, missile, and aircraft components has led to the installation of many furnaces for this purpose. It is interesting to note that the inverted pit furnace, so popular today, was originally invented in 1928 for the heat treatment of aircraft components.

As a service to industry and as a means of providing complete data about this equipment, *Metal Treating* conducted a survey and compiled the data tabulated here. Photos of some installations are provided on pages 6 and 7.

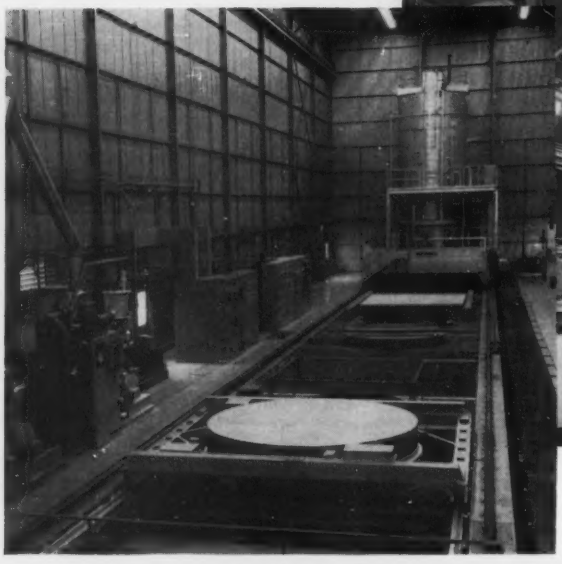
The following companies indicated their intentions of building equipment of this type or adding to their existing facilities in the near future. Information will be published regularly as the units are completed and available for production.

Aerojet-General Corporation
Alco Products Manufacturing Co.
Commercial Steel Treating Corp.
General Electric Company
Lindberg Steel Treating Co.
Marquardt Corporation
Metlab Company
J. W. Rex Company
Thiokol Chemical Corporation
Thompson Ramo Wooldridge, Inc.

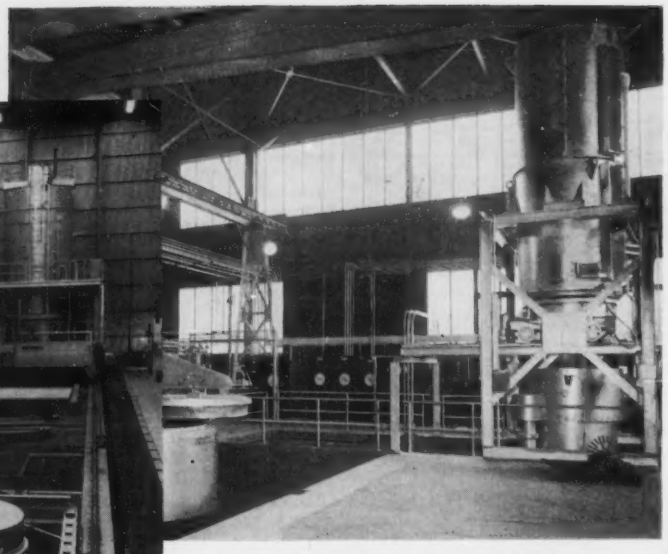
The subject is of extensive interest, and *Metal Treating* invites comments, additional information, or further details from its readers.

SPECIAL HEAT TREATING FURNACES FO CK

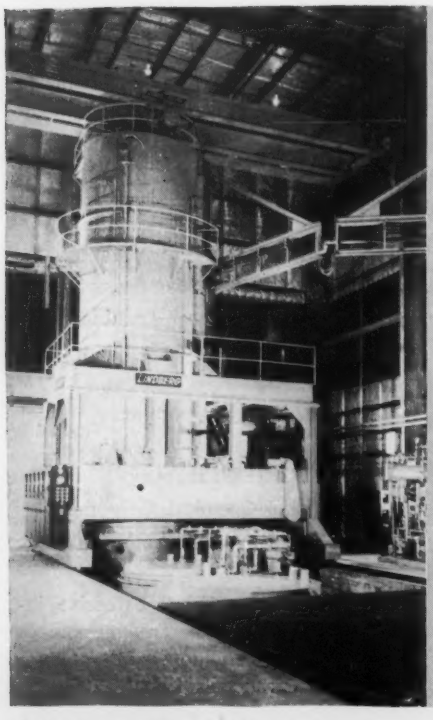
*Details on pages 4-5



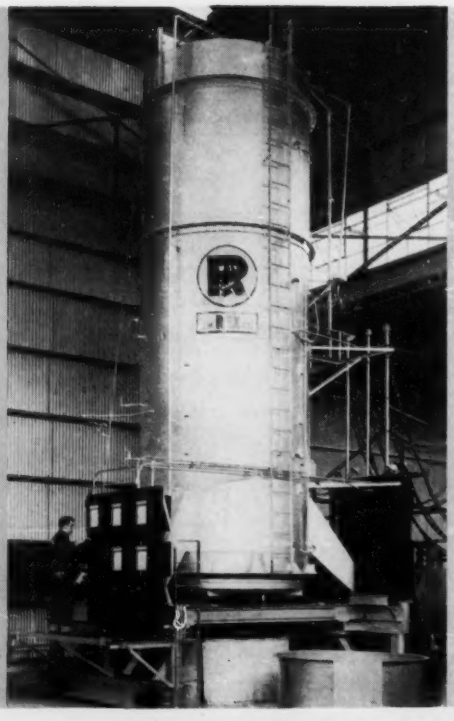
AEROJET-GENERAL CORP.



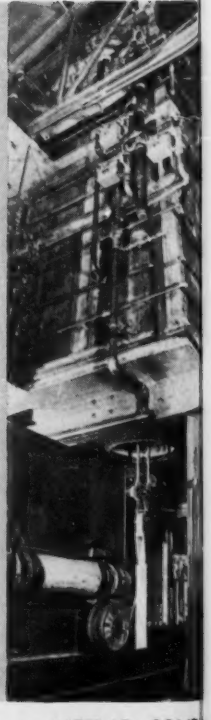
ALCO PRODUCTS MANUFACTURING CO.



LINDBERG STEEL TREATING CO.



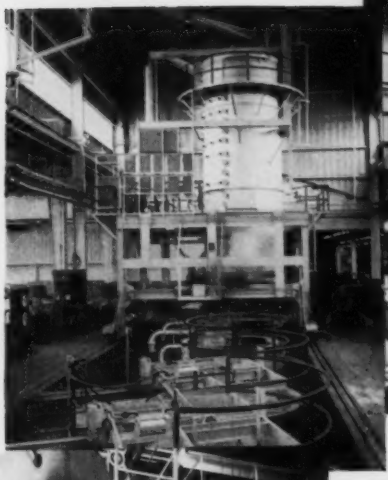
J. W. REX COMPANY

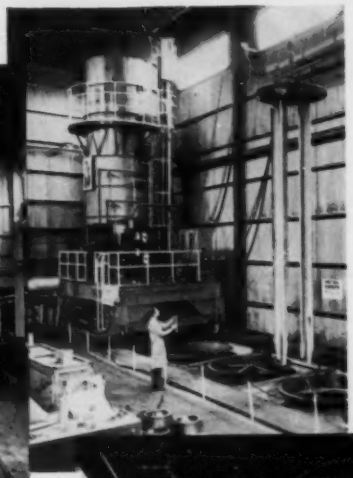


METLAB COMP

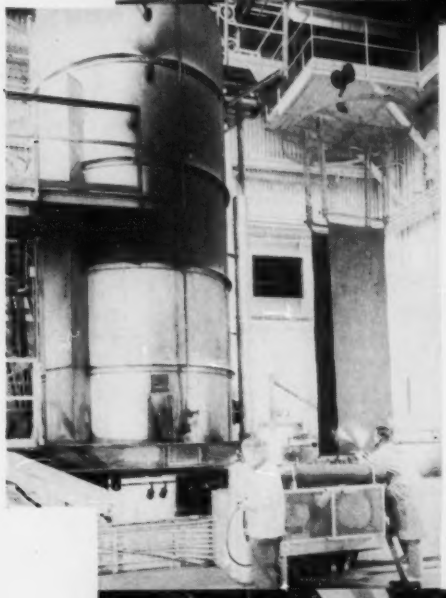
)CKET, MISSILE, AND AIRCRAFT PARTS*

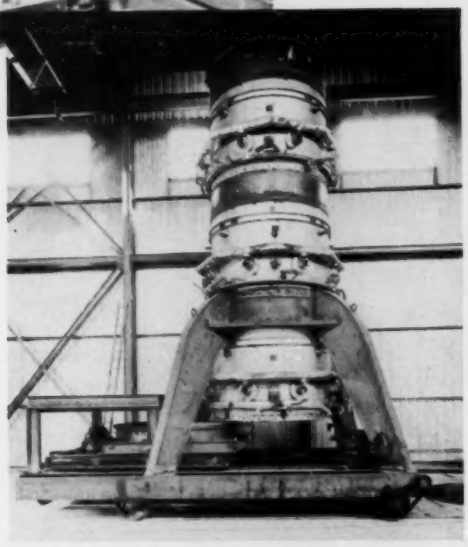
GOODYEAR AIRCRAFT CORP.



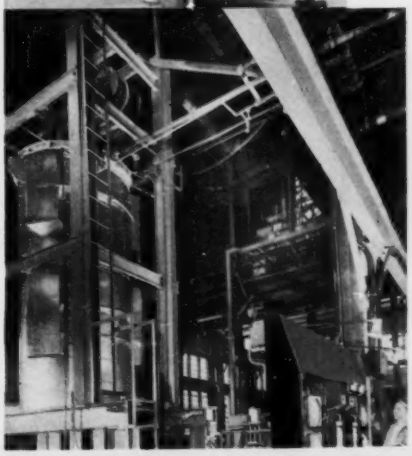


METALLURGICAL, INC.

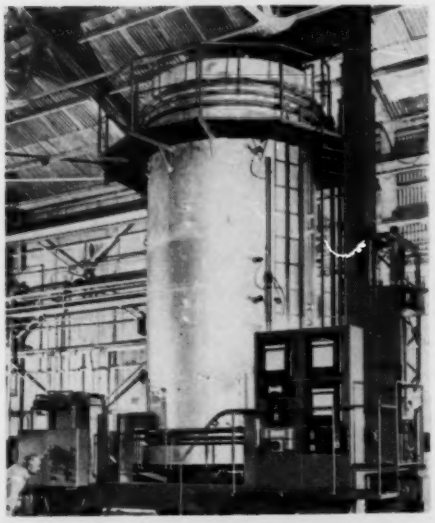




COMMERCIAL STEEL TREATING CORP.



PITTSBURGH COMMERCIAL HEAT TREATING CO.



CALIFORNIA-DORAN HEAT TREATING CO.

HIGH FREQUENCY RESISTANCE HEATING FOR WIRE ANNEALING

By **HUGH CAMERON,** Engineer
New Rochelle Tool Corporation
New Rochelle, N. Y.

A RADICALLY NEW method of annealing ferrous and non-ferrous wire has been developed. This electronic equipment, utilizing the principle of high frequency resistance heating to anneal almost any metal wire that can be water quenched, has been developed and is being manufactured by the New Rochelle Tool Corporation, New Rochelle, N. Y. This company has pioneered the development of high frequency resistance heating for industrial use, and as far as is known is the only organization manufacturing patented equipment utilizing this phenomenon.

Seam welding by this method has been incorporated in over fifty-nine tube mills around the world, and tubing welded by Thermatool equipment is being produced at speeds never before thought possible and with greater economies. The use of high frequency resistance heats metals faster and with greater consistency than any other known method, and controls the heat where it is needed to effect the desired result.

For the past five hundred years, the brass industry has annealed wire by rolling it into coils, piling these coiled lengths on a floor, putting a batch type furnace over the product, heating the piles up to annealing temperature and then letting them cool slowly. In many cases, an inert or reducing type of atmosphere has been introduced inside the furnace to stop scaling or oxida-

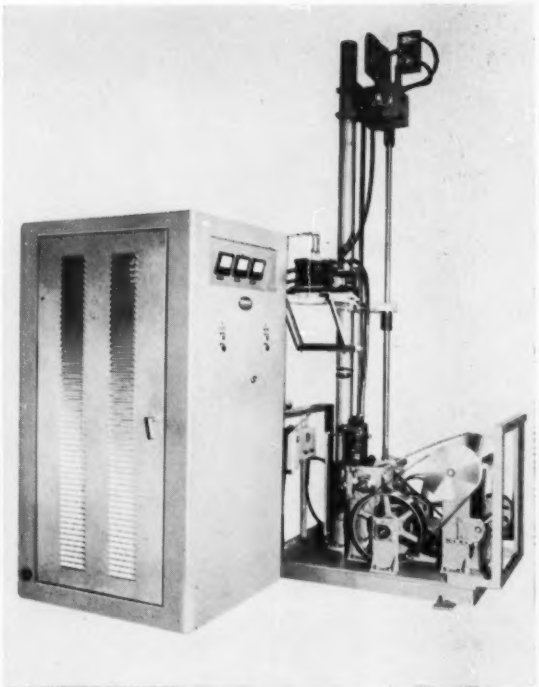


Fig. 1—This new wire annealer uses high frequency resistance heat and comes as a complete package unit including generator, water economizer, voltage regulator, and wire feeding device.

tion. In some instances the coils of wire have been passed through a furnace on a conveyor. These methods are cumbersome, slow and not economical.

In the modern production of wire from billet to the desired size, the strand travels at a very high speed (200 to 3000 feet a minute) through various dies, and this working of the wire causes it to become hardened and embrittled to the point where further drawing will cause it to break. Annealing is performed one or more times during the drawing operation.

Obviously, if wire can be annealed continuously, considerable money can be saved in its manufacture. This has been practiced for many years by passing wire through a furnace. This method is expensive, slow and not adaptable to continuous drawing operations.

Another method of annealing wire is to pass a 60-cycle current through it and heat it by its own resistive losses. This use of low frequency current has been attempted many times with inconsistent results. In this method the wire is passed around a sheave, then around another sheave while low frequency current is caused to flow through the wire from one capstan to the other. The use of 60-cycle or even 300 to 400 cycle current is unsatisfactory due to the fact that marks occur on the surface of the wire as it leaves the sheave. These marks on the wire damage dies in subsequent drawing, and also make the product unsalable for many uses.

The Thermatool annealer passes 450,000 cycle current directly through the wire and heats it by high frequency resistance losses, and no arc or marks occur. The wire passes into a feed roll system which guides it vertically through a seven-foot, glass-lined tube. High frequency current enters the wire at the top and leaves at the bottom by means of contacts. The lower six inches of the unit is a quenching device which removes the heat from the wire before it hits the lower contact. The tube around the wire acts as a coaxial return conductor.

The wire carries several hundred amperes of current between the two contacts and in travelling rises in temperature to some pre-set value, such as 1250°F, and then enters the quench. The quench extracts the heat from the wire and allows it to hit the second contact in a nearly cold condition. If it hit the second contact in a hot condition the wire would be marked.

The equipment includes a generator, water economizer, input voltage regulator, a mechanical wire guiding and feeding device, and an automatic length compensator for changes in length of wire during the annealing operation. (See Fig. 1). The device is a complete package unit which can be installed in a wire-drawing line as an interim annealing operation, or as an annealing device for transferring wire from one reel to another, annealing in the process. No wire pulling or reeling devices are included with the equipment, as the pulling is usually done by a wire draw mill or bull block.

At the present time, the equipment is limited to wire diameters between 0.128" and 0.030", and two sizes of power supply are available—25 kw and 60 kw. A 25 kw unit will produce 300 lbs. of brass or bronze wire per hour (700 ft. per minute for 0.051" diameter, or 100 ft. per minute for 0.128" diameter). A 60 kw unit will produce 720 lbs. of brass or bronze wire per hour. Production of other metals is dependent upon the temperature required for annealing. Larger capacity machines are capable of higher production.

The mechanical feeding and guiding device is limited to a top speed of approximately 1,500 feet per minute. The floor space necessary for the mechanical guiding and feeding device and automatic length compensator is 4 by 3 feet and the equipment is about 11 ft. high. The floor space required for the high frequency generator is dependent upon the size unit employed. The 25 kw generator is three by four feet and seven feet high. The 60 kw is only slightly larger. Developments are now in progress which will permit greater speeds.

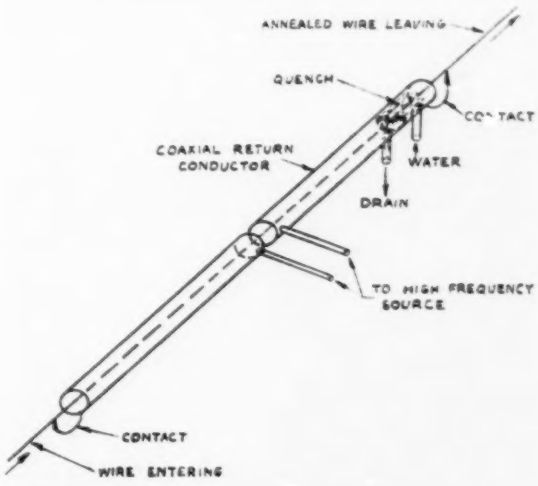


Fig. 2—Wire annealing by high frequency resistance heating.

The new annealer was developed and tested over a two year period by the New Rochelle Tool Corporation before it was put into a production line at Seymour Manufacturing Company, Seymour, Conn., where it has proven that high frequency resistance annealing surpasses any present method. Originally designed to better the quality and to expedite the production of bronze wire, especially the type used by manufacturers of Fourdrinier mesh, it is now possible to anneal any ferrous or non-ferrous filament, with the exception of zinc, certain zinc alloys and magnetic steel. • • •

THE COMMERCIAL OPERATION OF A HIGH VACUUM HEAT TREAT PLANT

By **JOSEPH B. MERRILL,** President
High Vacuum Equipment Corp.
Hingham, Mass.

KINETICS CORPORATION, Hingham, Massachusetts, a commercial heat treating and brazing facility, has been engaged in vacuum processing metals since 1954. It is a wholly-owned subsidiary of High Vacuum Equipment Corporation, which, in turn, is a wholly-owned subsidiary of Robinson Technical Products, Inc., Teterboro, N. J. The operation of this facility has been particularly interesting because it covers the period during which the use of vacuum in metallurgical applications has gone through its most revolutionary changes. It has seen vacuum processing grow from a point where it was used reluctantly as a tool of last resort to where it has become generally accepted as a dependable, low-cost processing medium, completely free of hazards as compared with many types of gas atmospheres. The operation of a vacuum furnace is far less complex than the control of conventional protective atmospheres. This article will describe briefly the changes and scope of requirements that have taken place between 1954 and 1958.

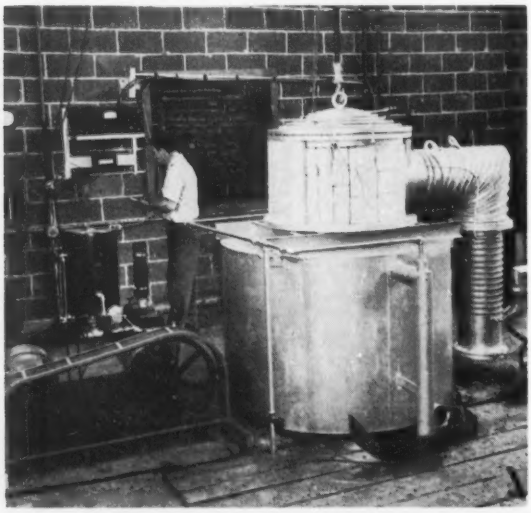


Fig. 1—Retort and cooling chamber of Kinetics' first high vacuum heat treating furnace, a single-pumped unit capable of a maximum temperature of 1650°F. Millions of dollars worth of scrapped titanium aircraft engine components were reclaimed by removal of hydrogen. (Note schedule on blackboard in background).

During 1954 Kinetics' efforts were devoted exclusively to the removal of excess hydrogen from titanium. The sole customers were the aircraft industry. A challenge given them was to determine the time, pressure, and temperature cycles required to remove excessive hydrogen from titanium components having varying cross-sectional thickness. Once these were established, and knowing the hydrogen content of the inbound material, they could predict with almost 100% certainty the time required to bring the hydrogen content of nearly any titanium part down to acceptable levels.

The temperature never exceeded 1650°F and indeed, at that time 1750°F seemed a high temperature for a large vacuum furnace. They started with one single-pumped, pit-type furnace, having a heated volume approximately 3′ by 3′. This capacity was soon doubled by the addition of a similar furnace, and processing was carried on through a twenty-four-hour day, seven days a week, with relatively unskilled labor. The greatest problem during 1954 and into 1955 was a series of hurricanes that swept along the coast and threatened to cut off the power. Power was lost on only two occasions, but the loads valued at around $50,000 were saved by backfilling the retorts with helium. (See Fig. 1)

As soon as it became evident to titanium producers that high hydrogen content in titanium was threatening their existence, they immediately set out to produce material with a lower hydrogen content and they succeeded in doing just this. While some titanium must still be degassed in the solid state, the bulk of it needs no further processing.

Thus it was Kinetics now whose existence was threatened, and indeed, if other applications were not discovered or developed the company must surely cease operations. In late 1955 they investigated other fields —the atomic energy program, the electronics industry, the missiles field and the aircraft industry. The outlook was promising as far as vacuum processing was concerned, but it appeared that their 1650°F furnaces were obsolete. Many required operations had to be performed at temperatures as high as 2250°F. Heating element manufacturers and the International Nickel Company had no data on their materials if operated in vacuum at these temperatures, and they frankly advised them against trying to operate with their materials under these conditions. A few tests similar to those conducted by Mr. W. A. Bonn of General Electric Company gave encouragement. In 1956 they disposed of one of the 36″ x 36″ single-pumped furnaces and converted the second one to a double-pumped unit. With a great deal of relief, it was discovered that the ¼″ thick Inconel® retort and the Nichrome V heating elements behaved beautifully at 2250°F and intermit-

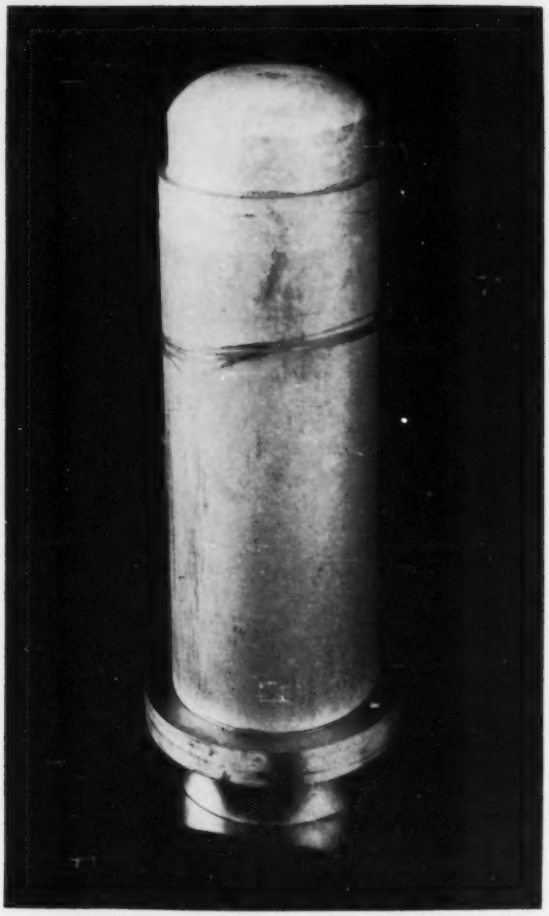


Fig. 2—This is an OFHC Copper Anode 6" in diameter by 21" in height, to be used in a large power tube. It is shown after vacuum brazing with NICORO (a gold, copper, nickel alloy) at 1945°F. Many similar anodes are vacuum annealed at Kinetics between deep drawing operations.

tently at 2300°F with several thousand hours of trouble-free service. They later built a virtual duplicate of the 36" x 36" unit and followed this with a smaller 12" x 24" double-pumped unit.

By now, titanium processing had virtually disappeared from the picture. With the new 2250°F furnaces in operation, they were in a position to handle a variety of other work. For the atomic energy field, the company now began processing reactive metals such as zirconium and uranium alloys in quantities up to one ton per cycle. These were mostly annealing and degassing runs, and the main problem to be overcome consisted of preventing contamination on the surface of the metal. In general, these materials were far more susceptible to this than titanium. This trouble was finally traced to poor cleaning of the metal prior to vacuum processing and back-streaming oil vapor from the diffusion pump during long holds at equilibrium pressure. Proper cleaning of the material and the installation of effective cold traps eliminated this.

For the electronics industry they were processing internal components of vacuum tubes. By handling these parts in large quantities and having a pumping system capable of handling the gas as rapidly as it was evolved, costs were reduced. They did this by cutting the exhaust times of many of the tubes in half. Furthermore, tubes made with the degassed metals seemed to have a longer shelf life. On large power tubes they were frequently able to braze sections to each other in a vacuum, and the outgassing that took place at the same time was a dividend. (See Fig. 2).

During 1957, for the missile field, aluminum and titanium bearing alloys were brazed successfully without the use of flux. The joints had excellent mechanical strength, and the stainless alloys came out of the furnace with a brighter surface than when they went in. Thin-section, lightweight, heat exchangers were also brazed by this method. (See Fig. 3).

Similar materials were brazed for aircraft applications along with several new ones. Titanium and titanium alloys, as well as honeycomb structures, were brazed. Interestingly enough, many specifications were now being written calling for more and more assemblies to be vacuum brazed. The work carried on by Ernie Huschke at General Electric Company was establishing the superiority of this type of joint for many applications.

Freedom from voids and nearly 100% bonding of large flat surfaces is characteristic of vacuum brazed joints. Neither flux nor air is present, and the absence

(Continued on page 28)

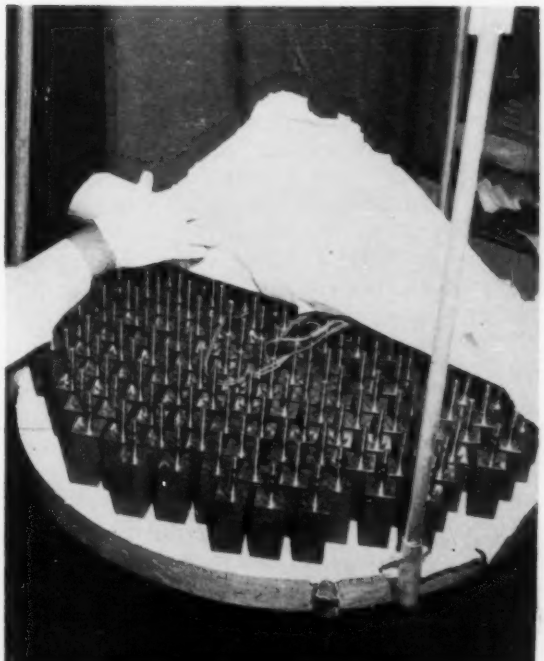


Fig. 3—This customer had finish-machined to .0002" the spindle section of several thousand A-286 vanes for aircraft gas turbines when it was discovered that fatigue strength of the raw material did not meet specifications. This was corrected by "aging" in vacuum for 16 hours at 1200°F. The photo shows only a single layer, consisting of approximately 75 pieces.

NEW PROFIT SOURCES OPENED TO HEAT TREATERS

By **PAUL G. MUNGER**
The Systems Company
Arcadia, California

NEW FIELDS for the heat treating and brazing industry affording sources for substantial profits in processing a broad range of products in many industries are opened to the progressive heat treater and brazer by the perfection of metallurgical techniques for inexpensively plating ferrous metals and copper with a protective surface equal or superior to pure nickel in resisting the attack of alkaline chlorides, chlorinated hydrocarbons, fruit juices, fatty acids, sour crude oils, salt water and an array of other corrosive media. Thus, corrosion and oxidation, long the bane of metals, a source of expense to industry and of problems to the engineer have suffered new set-backs.

"Pyro-Plates" is the trade name for a family of patented paint-like compositions, one of which, Pyro-Plate Nickel paint, is capable of depositing a layer of nickel, iron or cobalt on metal surfaces when heated under reducing conditions. Requiring no special surface preparation or equipment other than the standard controlled atmosphere furnace of the heat treater or brazer, the plating possesses a number of attributes superior to conventional electrolytic and chemical plates.

Unique Characteristics Displayed

Most outstanding is the metallurgical bond produced when Pyro-Plate Nickel is reduced by furnace or induction heat. Fused to the surface of the parent metal the plating cannot chip, crack, flake or lift when exposed to corrosive media even after bending or drawing of the base metal. In fact, when properly applied, it is ductile, pore-free and an integral part of the metal surface to which it is applied. When deeply scratched or cut through to the base metal, it exhibits a self-quenching action inhibiting corrosion beyond an initial indication of rust.

Unique also in the field of platings is the ability to apply this coating to interior surfaces such as inside tubing and valves where electroplates are extremely difficult or impossible and to plate sharp edges and interior and exterior threads without the prohibitive build-up experienced in other processes.

Plated parts fabricated by welding display no peeling of the coated surface, and use of welding electrodes high in nickel content effects a joint with maximum corrosion resistance and strength.

Iron castings that have been plated have no build-up or increase of their surface dimensions, all of the plate being absorbed into the casting to form a case resistance to both corrosion and oxidation and increased hardness from approximately 20 Rc to 45 Rc.

As a stop-off coating in carburizing operations, the paint has great merit, and in paste form is superior for corrosion and oxidation resistant brazed joints. A high lustre results when the plate is buffed and colored by conventional polishing methods.

Other unusual attributes of the paint are exceptional gall resistance when run against unlike materials such as steel, cast iron, chrome plate, etc., prolonged resistance to oxidation at temperature as high as 1500°F in open air, and simple and inexpensive methods of application.

Methods of Application

Pyro-Plate Nickel compositions have a high wetting action on metals. An organic suspension assures adhesion of the coating prior to heat processing. Applied by brush, spray or dipping, the paint dries in minutes and, when reduced by heat, forms a very uniform plate from as little as .0001″ thick to over .007″ thick depending on viscosity of the paint and method of application.

Preparation of the surface to be plated is unnecessary other than to have it clean. Oil, grease, mill scale, oxide, phosphate coating, paint, and the like must be removed before Pyro-Plate Nickel paint is applied. This is accomplished by an aqueous or vapor phase de-

greasing bath or by sand or grit blasting of the parts. Inaccessible interior areas are readily covered by dipping or pouring paint into the cavity and allowing the excess to drain away. Applied to specific areas by brush, the need for masking is eliminated.

To assure proper plating, cast iron surfaces are "ground" or machined to eliminate inclusions or voids in the "as cast" surface which make pore-free plating very difficult. Castings, barrel burnished or grit blasted with 100 mesh or finer grit have proven a convenient and satisfactory method of surfacing prior to applying the coating.

If protection against oxidation only is required, a pore-free plate is unnecessary. Expansion of the thin oxide coating formed during oxidation seals the minute pores in the plate.

Thickness of the paint coating is important in plating for proper corrosion resistance. Applied to a clean, smooth surface the paint assures corrosion and oxidation resistance equal to and in most cases superior to wrought or electrolytic nickel plate. However, the plating thickness necessary for adequate corrosion protection is dependent also upon the roughness of the metal sub-surface. As little as .0001" is satisfactory on a ground or polished base while rough surfaces may require from .0005" to .001".

Small metal parts are plated by placing in a basket, dipping them in a thin solution of the nickel paint and then shaking or spinning off the excess. Parts coated in this manner and reduced by heating will not stick together, and the self-fluxing action of the paint compositions allows the alloy plate to flow evenly over the base metal without troublesome build-up on sharp edges or fill-up of threads experienced with electrolytic plates and galvanizing.

Pyro-Plate Nickel is adaptable to all ferrous metals such as wrought iron, cast iron, steel, stainless irons as well as copper, nickel, cobalt, etc.

Reduction by Conventional Heat Treating Equipment

Reduction of the dry paint coating to a metal alloy plate is accomplished by furnace or induction heating of the type which is standard procedure with heat treaters or brazers. In fact, the reduction procedure, if desired, may be an integral part of the normalizing, stress relieving, carburizing or hardening processes using heat in the range from 1650°F to 2100°F. Also required is a controlled atmosphere. In practice, the paint-like coating, being an oxygen-containing compound of nickel, iron or cobalt, melts to form a low melting point alloy plate brazed to the base metal. Without a controlled or reducing atmosphere, both the base metal and the composition oxidize rapidly in the heat, and plating does not occur.

The reducing atmosphere may be any atmosphere reducing to iron oxides at 1650°F or higher. Hydrogen, dissociated ammonia, exothermic, endothermic or natural gas is suitable. Hydrogen or dissociated ammonia, however, produce the smoothest, brightest plates where appearance is a factor; and in endothermic atmospheres, an air to gas ratio of at least 10 to 1 is best to prevent carbon deposition.

Plated parts must, of course, be allowed to cool to 600°F or less in the atmosphere to prevent oxidation and discoloration of the plate when removed from the furnace.

Efficiency Test

A fast, inexpensive test may be applied in the processor's own establishment to determine the continuity of Pyro-Plate plating. A solution of 1 gallon of water, 8 ounces of salt, and 4 ounces of hydrogen peroxide is an extremely vicious corrosive media. Plated parts immersed in this solution will show rusting at any discontinuities in the plated surface within 30 minutes. The remedy is just as simple. Rejected parts washed in water, spot grit blasted to remove the rust, repainted and heated again plates the exposed base metal. Parts may be plated repeatedly with the coating to build up a plating of any desired thickness if one thick plate is insufficient.

Since many factors are involved in corrosion, actual tests of plated parts in the corrosive environment concerned are desirable where possible.

Wide Application

Although perfected and released for industrial use but recently, Pyro-Plate Nickel has undergone extensive testing in a wide variety of industrial applications. Plated products tested and now in regular production include cast iron glass molds (plated to resist abrasion) that have shown much extended life and reduced maintenance cost; hot work dies (plated to resist oxidation) which accomplish all that very expensive stainless steel dies do plus better heat transfer characteristics; oil tools withstanding abrasion and corrosion in wells where hard chrome plate peels off; marine hardware and pole line hardware protected against corrosion; and many other applications in which plated parts are now undergoing tests or have been accepted. The extent to which this coating may be employed in plating for corrosion resistance is almost unlimited. Foreseen is the possibility of plating large structural steel beams and transmission line tower steel by induction heat to eliminate the need for painting.

Noteworthy and obvious is the fact that the coating family of metallurgical processes and compositions are basic in affording superior corrosion and oxidation resistance to a multitude of products. Their potential, however, goes beyond this in offering to prospective new businesses the nucleus to enter a market with superior products.

Underlying the basic patents are additional processes for plating which provide maximum abrasion resistance simultaneously with corrosion and oxidation protection to round out the family of Pyro-Plate metallurgical compositions. • • •

HEAT TREATING HINTS

ON THE FORMATION OF MARTENSITE

By E. J. PAVESIC

In the last issue (July-August) data was presented showing the relationship between carbon content and the Ms temperatures for 44 carbon and alloy constructional steels. The effect of austenitizing temperature on the Ms temperature of AISI-SAE 52100 (a bearing steel) was also shown.

While the Ms temperature is of great importance, the Mf temperature is of still greater importance for the following reasons:

1) It represents the temperature at which the last traces of austenite are transformed to martensite. Hardening is complete at this point and the steel is ready for the tempering operation.

2) The austenite-to-martensite transformation is accompanied by an increase in volume, the magnitude of which is related to carbon and alloy content. This transformation and volume change results in the development of residual stresses at times sufficient to cause cracking. As the Mf temperature is lowered, the final transformation takes place in a martensitic matrix, which is highly stressed and which is relatively incapable of absorbing the stress imposed by the austenite to martensite transformation. The propensity to cracking is thereby increased. Tool steels and particularly those high in carbon are affected by this phenomenon because their Mf temperatures range from less than 80° to about 150°F. Any transformation to martensite which occurs below about 250° to 300°F does not benefit from the self-tempering action as do steels which are completely transformed at or above these temperatures.

3) Steels with low Mf temperatures, such as the high carbon and alloy tool steels, complicate the heat treating procedures to the extent that very careful control and special precautions are necessary. Generally speaking, a steel must be hardened before it can be tempered. While this statement sounds trite, it is nevertheless true, and especially so when applied to steels with low Mf temperatures.

For example, when a tool steel of AISI-SAE type 01 is quenched from its normal hardening temperature, it must be cooled to about 100°F before it is tempered. If it were cooled to 200°F before tempering, there would be about 5 per cent retained austenite present in the microstructure. Tempering at 400°F would have little effect upon the retained austenite; and consequently, when the steel was cooled to room temperature, the austenite would transform to martensite, increasing the propensity to cracking and certainly increasing the magnitude of residual stresses. If the steel was allowed to cool to about 100°F after the initial tempering and then retempered, the newly-formed martensite would be tempered and the level of residual stress reduced. Therefore, if a steel is not cooled to or below the Mf temperature on quenching, it should be tempered twice.

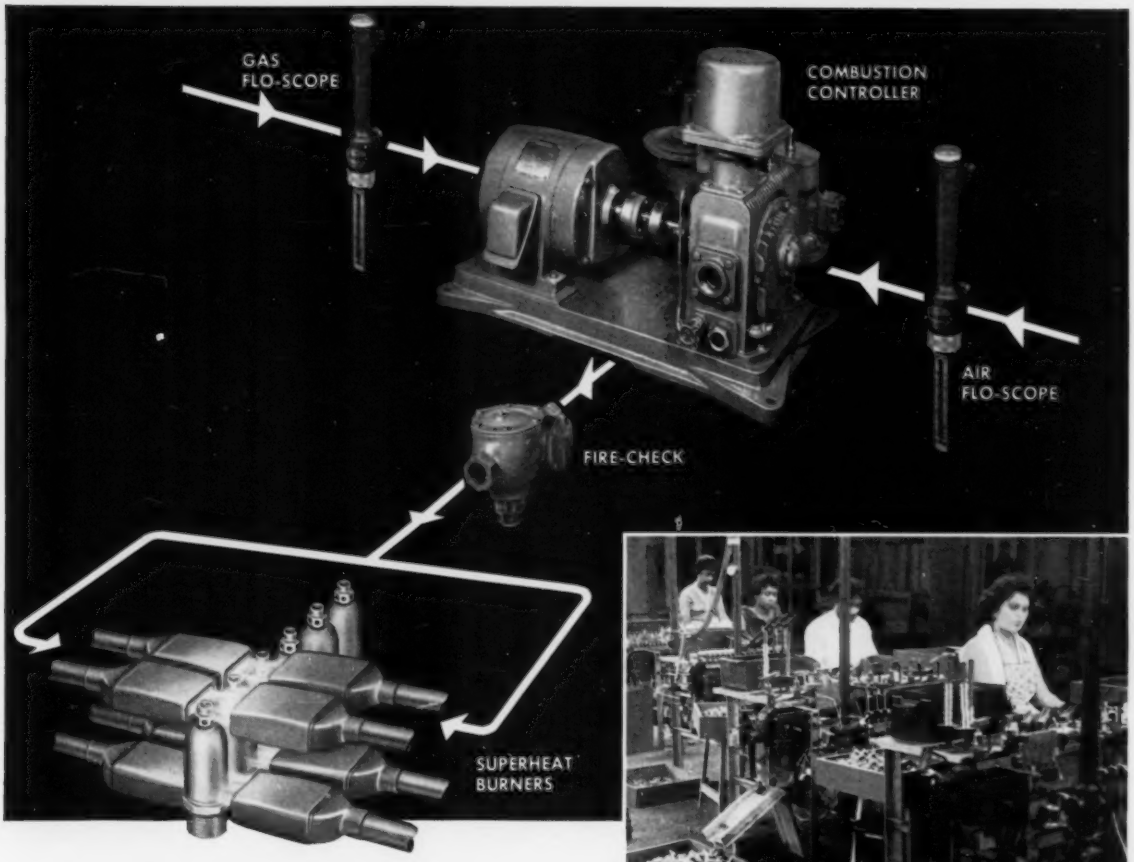
A steel improperly hardened and/or tempered will not necessarily crack in heat treatment. However, the magnitude of residual stress may be such that with loads normally applied in service, failure may occur prematurely. Double tempering provides a considerable safety factor in this respect.

Sub-zero treating is often resorted to for the purpose of transforming retained austenite, but when performed directly from the quench it may be extremely hazardous if not disastrous, especially if the workpiece is of a complex shape and large mass. Tempering prior to sub-zero treating mitigates the stresses (and hazards) resulting therefrom.

Some steels, such as the 18-4-1 high-speed steels, retain as much as 20 per cent austenite upon quenching. Such steels are multiple-tempered in the range of 1000° to 1100°F to transform the retained austenite. Here again sub-zero treating would be too hazardous and is never used directly from the quenching operation.

The major source for information on the temperature range of martensite formation (Ms to Mf) is the isothermal transformation diagram, more commonly referred to as the T-T-T or S curve. Empirical formulas for calculating the Ms temperature and the per-

(Continued on page 46)



Operators assemble and load air-venting valves onto conveyors of machines, which braze up to 600 workpieces per hr. Diagram shows two pairs of Selas Superheat burners at top, two pairs of larger Superheats at bottom, adjusted to synchronize brazing of both ends simultaneously in approximately 4 sec. Brazed valves withstand 5000 psi pressure.

Selas Superheat Burners Speed Brazing, Soldering of Valves.. Increase Strength, Quality

Flair Manufacturing Company, Brooklyn, N. Y., recently discarded conventional heating methods for valve assembly . . . stepped up the production rate and quality of its air-venting valves with compact, conveyorized machines equipped with Selas Superheat burners.

The accurate directing of heat, versatility and control of heat input provided by these burners have overcome valve rupturing, and have increased brazing and soldering production rates to 600 valves/hr, with virtual elimination of rejects. Unskilled labor handles the work with ease.

At Flair, and throughout the metalworking industry, Selas provides a complete combustion package to assure most efficient operation of Superheat burners:

- Combustion Controller—makes possible fast heating and close control, by delivering gas-air mixture to burners at preset ratio and pressure. Completely automatic; no labor required in its operation. Factory Mutual approved.
- Flo-Scopes®—installed at the inlets to the Combustion Controller, Flo-Scopes measure rates of flow of gas and air and permit accurate determination of gas-air mixture ratios.
- Fire Check—gives complete assurance of safety by automatically extinguishing any flashbacks that may occur. Factory Mutual approved.

Standard Superheat burners can be utilized in open arrangements . . . in-line . . . in circular rings . . . in spirals . . . individually . . . in opposed pairs. Special Superheat designs custom-built to meet your specific needs.

Selas also offers other types of burners including Duradiant, Refrak, Spear-Flame and Ribbon.

These combustion components are available individually or as a complete combustion package.

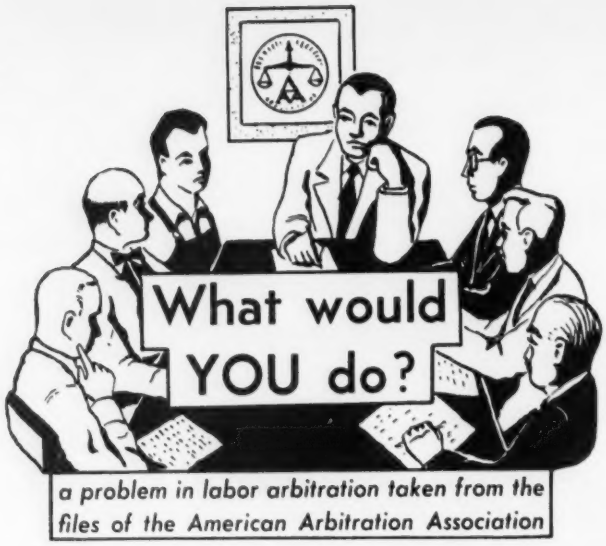
For descriptive literature on any of the above combustion components, write Dept. 69, Selas Corporation of America, Dresher, Pa.

Duradiant and Flo-Scope are registered trade names of Selas Corporation of America.

SELAS CORPORATION OF AMERICA DRESHER, PENNSYLVANIA

Heat and Fluid Processing Engineers

DEVELOPMENT • DESIGN • CONSTRUCTION



The Case of the Sleepy Riveter

In a mere five months of employment, Tony G., a riveter in a structural steel fabricating plant, managed to build up quite a record of plant rule violations. He was warned for visiting the first aid room unnecessarily, for loitering in the men's room, for careless work and for absenteeism without excuse. When he was caught sound asleep behind a pile of girders, one day, management decided things had gone far enough. He was fired on the spot.

"We admit that Tony may have deserved discharge," protested the union, "but according to the contract, the union has to be notified in advance when an employee gets his final warning. You didn't follow the procedure of the contract, so you have to give him one more chance."

Management didn't see it that way. "That clause you're talking about applies to situations where we decide to issue a final warning. In that case, we notify the union as well as the employee. But in Tony's case, there was no need for final warnings. A man can be fired at any time for sleeping on the job."

Eventually, the case went before an arbitrator selected from the panel of the American Arbitration Association.

What Would YOU Do?

THE AWARD: The arbitrator said that sleeping on the job, by company rules and practice, was a dischargeable offense even in the case of an employee with a good past record. Under the circumstances, the failure of the company to notify the union of a final warning could not invalidate the discharge. The warning procedures were intended to cover situations where management wanted to fire a man for an accumulation of *minor* offenses, no one of which by itself would justify discharge. Tony stayed fired.

The Case of the Short-Changed Finisher

Under the union contract in a furniture manufacturing company, employees who were temporarily transferred for the convenience of the company from incentive work to time work were to be paid their average incentive earnings. One day, a television cabinet finisher who had been accustomed to earning 30% over base rates was asked to help out on another line. Although the temporary assignment paid incentive rates, the finisher wasn't able to earn any. He consequently got paid the base rate for the job.

On pay-day, the employee expected to get his average earnings. But management didn't figure it that way. "We transferred you to an incentive job," explained the personnel manager. "If you had put your usual effort into the job you would have earned your customary 30% more. You slackened off, so you only get the base rate."

"I did put my usual effort into the job," answered the aggrieved employee. "The incentive rate is so low that for practical purposes it's a time job."

The union filed a grievance which eventually went to arbitration under the rules of the American Arbitration Association.

What Would YOU Do?

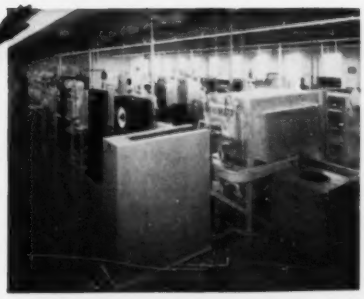
THE AWARD: The arbitrator said the contract very clearly required average incentive earnings to be paid only when a worker was transferred, at the convenience of the company, from incentive to non-incentive work. Since the finisher was transferred to incentive work, the guarantee didn't apply. If the temporary job had such a "tight" rate that the expected 30% over base couldn't be earned with normal effort, he added, it could be the basis for a different grievance. But since the issue before him was whether the guarantee applied, he had to answer in the negative.

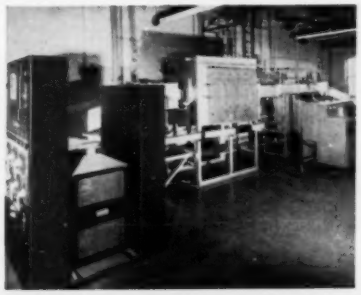
SEE THE ANSWER TO YOUR HEAT TREAT PROBLEM AT THE HAYES LAB

Ever since 1918, C. I. Hayes has maintained a laboratory of the latest *production-line* furnaces and allied equipment (not lab models) on which actual heat treating processes can be duplicated and evaluated. Here you can take an active part in developing the heat treat procedure that will give you the exact results you need. You participate, too, in developing equipment that's coordinated to your own particular work.

CUSTOMERS ARE WELCOME to make use of the lab without cost or obligation. Hayes equipment *plus* our engineering know-how *plus* the Hayes library of case histories—this combination is ready to help you solve your problems . . . either with standard furnaces, or special designs for special work.

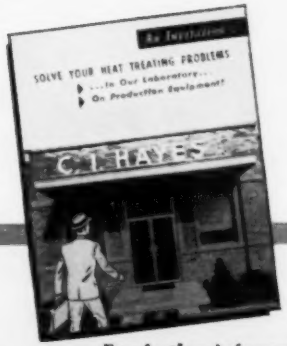
HAYES SHOWED THE WAY—others followed. There are several "Chinese copies" of the Hayes lab in industry today . . . proof positive that the right way to solve heat treat problems is the Hayes way—by experimentation and demonstration—not by "sweet talk".





WANT RESULTS GUARANTEED? Take advantage of our lab—and its range of furnaces and atmosphere generators—whether you're hardening low carbon steel, sintering refractory metals, or brazing stainless. Let us show you how to improve your product, reduce costs, and speed production.

BULLETIN 1961 gives full lab details . . . write for your copy today.



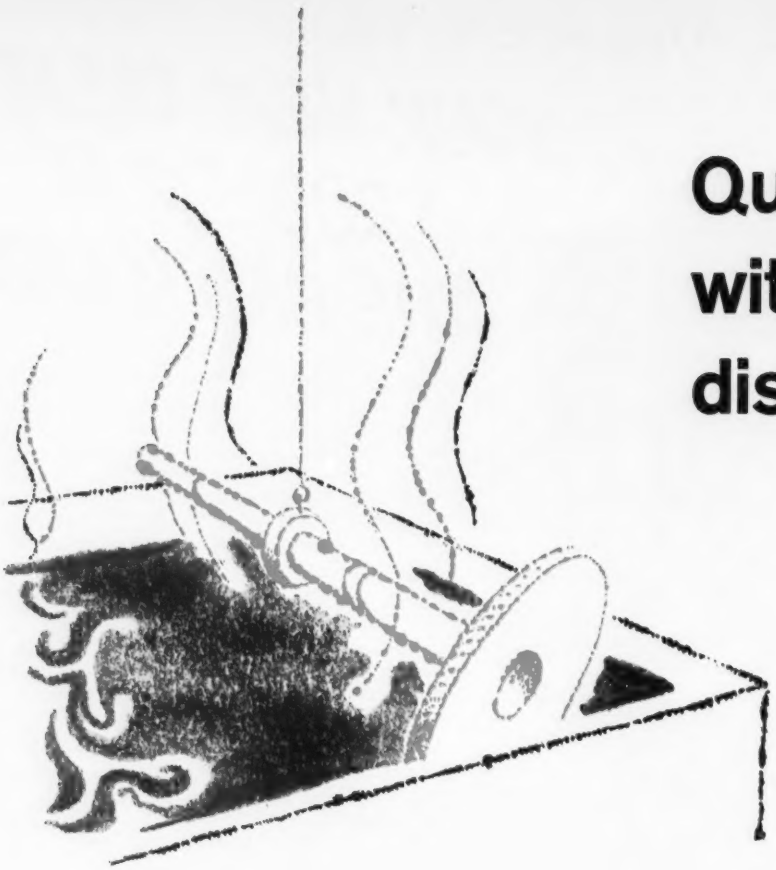
C. I. HAYES, INC.

Established 1905

816 WELLINGTON AVE., CRANSTON 10, R. I.

ELECTRIC CURTAIN FURNACES

For further information circle No. 70



Quenching... without distortion

Don't settle for simply the basic advantages of hot oil quenching. Particularly, if you work with special alloy steels, you should get these "extras" that Sinclair Marquenchol can give you... Extra Oxidation Resistance... High Flash and Fire Points... High Viscosity Index... Low Sludge Forming Characteristics

Find out more about MARQUENCHOL. Call your nearest Sinclair Representative or write for free literature to Sinclair Refining Company, Technical Service Division, 600 Fifth Avenue, New York 20, N. Y. There's no obligation.

Sinclair

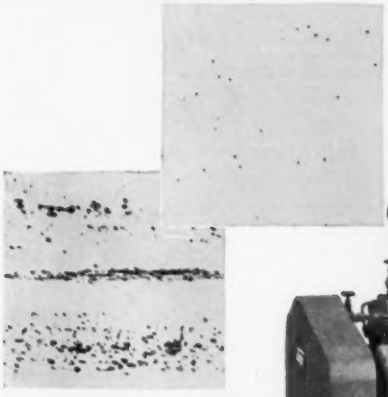
MARQUENCHOL Quenching Oil

perfect

MELT AND CAST PIECES UP TO 50 POUNDS IN THIS—

Kinney®

HIGH VACUUM FURNACE



Above—Cross section of vacuum molded billet. *Below*—The same metal but cast in atmosphere.

When you can't afford to let gases reduce the quality of your castings and run reject rates out of sight, the practical money-making aspects of KINNEY High Vacuum Furnaces assert themselves. The 50 pound model shown has found excellent application with high nickel steel, carbide tool steel, uranium and other metals. But, the value of this KINNEY Furnace is not confined to the more exotic metals . . . low alloy steels are dramatically improved by vacuum processing.

ADD TO MELT WITHOUT BREAKING VACUUM

You can introduce alloying material or add to the melt while maintaining a high vacuum in this versatile furnace. You can also operate the furnace using moderate positive pressure and an inert gas atmosphere.

ENGINEERED FOR PERFORMANCE

The furnace chamber features a full-opening hinged door or a rollaway type door with vertical or oblique split. Valving and special mechanisms for manual or automatic operation can be supplied and numerous accessories are available such as: various sizes of induction heating units, indexing of mold table, dip thermocouple and probe rod.

Complete your file of KINNEY High Vacuum equipment. Write for new Bulletins on Furnaces for Sintering, Annealing, Degassing, Brazing and Heat Treating.

AT THE METALS SHOW··· VISIT THE KINNEY BOOTH... Get the facts on what's new in High Vacuum

KINNEY MFG. DIVISION
THE NEW YORK AIR BRAKE COMPANY
3594K WASHINGTON STREET · BOSTON 30 · MASS

Please send us your latest literature on KINNEY High Vacuum Furnaces and KINNEY High Vacuum Pumps and Accessories.

Name_____

Company_____

Address_____

City_____ Zone____ State_____

ABSTRACTS

LIQUID FLAME HARDENING AND SPIN QUENCHING SOLVE HARDENING PROBLEM

Thanks to some sound help from two other companies, one manufacturer found the right road to sprocket hardening. Using liquid flame-hardening and spin-quenching methods, it was able to produce distortion-free parts at quite a saving.

Chain Belt Co. of Milwaukee makes chains and the gears or sprockets that drive them. A few years back, when sprocket making was just an infant in the Milwaukee plants, a thorough study was launched to obtain the best and most economical hardening technique. The approach was by trial-and-error.

Induction heating proved much too costly for the small-lot operation planned. Every size and type of sprocket would require a special coil. Ordinary flame hardening was a little cheaper in cost. However, it couldn't be counted on to produce the needed hardness pattern.

Then the engineers at Chain Belt heard about a salt-bath hardening technique called liquid flame hardening. It had been developed at the Yale & Towne plant in Philadelphia, which had problems in gear hardening similar to those in sprocket hardening.

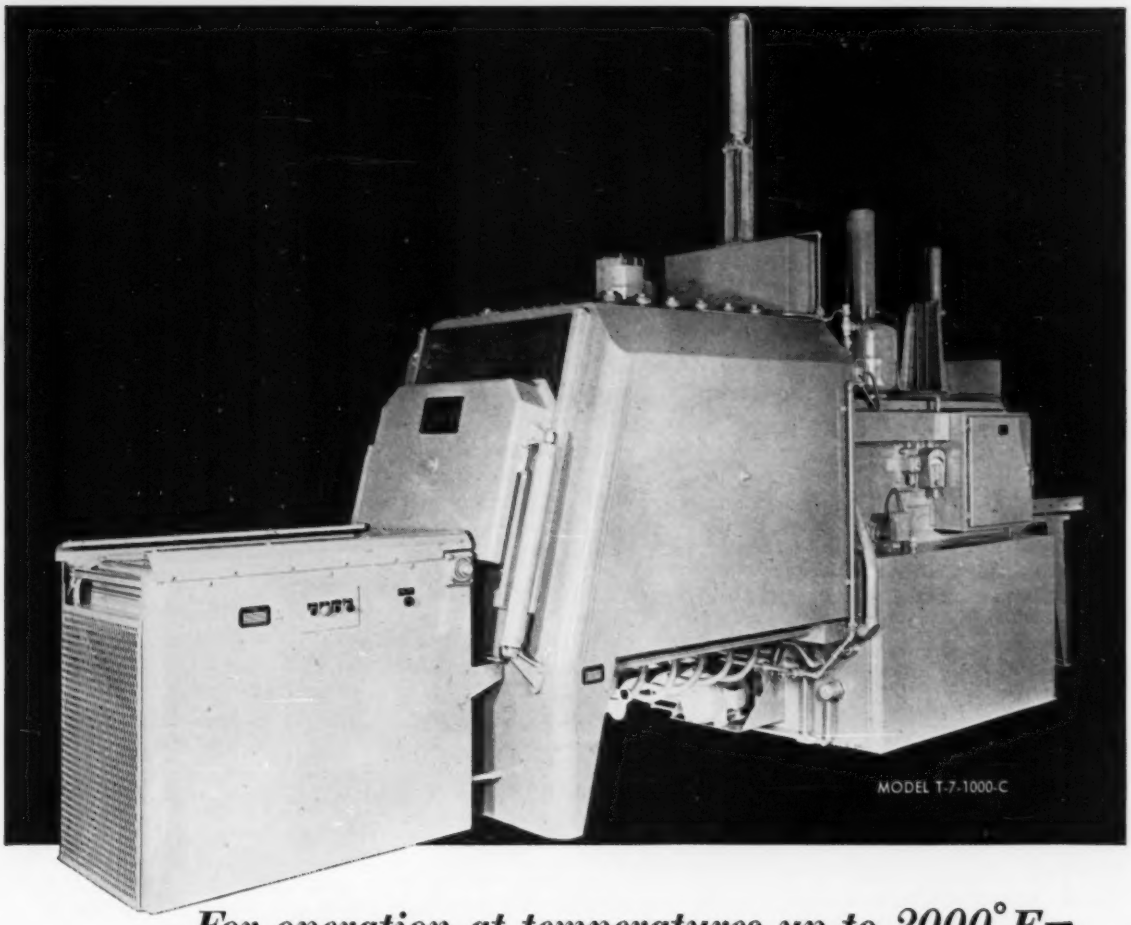
Yale & Towne used liquid flame hardening by supporting gears on a rotating mandrel above an electric salt bath and immersing only the teeth. It not only works well on small dissimilar lots, but the furnace can be used for other heat treating jobs too.

Chain Belt then ordered a salt bath furnace from another Philadelphia company, Ajax Electric Co. It was equipped with a Yale & Towne type fixture, a simple A frame with a freely rotating shaft.

The parts were spun at 45 rpm by a variable speed reducer and operation required two men. Soon after, sprockets were mounted on the shaft, the rotating device connected, and the entire assembly lowered until the sprockets were immersed right up to their rims.

After each cycle, the assembly was raised from the bath and the parts dip quenched. The results, unfortunately, weren't quite good enough. Too many sprocket resigns came out of treatment with soft

(Continued on page 53)



For operation at temperatures up to 2000°F—

the new model "C" Ipsen automatic heat treating unit

This is the new Ipsen automatic heat treating unit . . . designed for carburizing, carbon restoration, carbonitriding, neutral hardening, marquenching, normalizing, annealing, and brazing. Thousands of hours of continuous operation at 2000°F prove these units can easily withstand extremely high temperatures . . . as well as carbon-rich atmospheres.

The ability to operate continuously at elevated temperatures increases production and lowers costs. For example, raising carburizing temperature from 1700°F to 1900°F doubles the case depth obtained in 3 hours. The following table shows in greater detail how higher carburizing temperatures result in increased carbon penetration:

TOTAL CASE DEPTH FOR CARBURIZING C8620 STEEL

Temperature	1 hour	2 hours	3 hours
1700°F	.023	.031	.039
1800°F	.028	.042	.055
1900°F	.038	.060	.078
2000°F	.052	.081	.104

A newly published bulletin (T-19-C) discusses, in detail, patented Ipsen features and engineering advancements such as:

- "Straight-through" design which eliminates in-and-out operation and needless loading delays or extra handling.
- Automatic loaders and in-line transfer mechanisms (which require floor space only 6" longer than actual work baskets).
- Guaranteed super-alloyed ceramic heating tubes which are impervious to high carbon and high hydrogen atmospheres . . . resist extreme temperatures of heating and cooling.
- Patented super-alloyed ceramic "Flame-Busters" which increase heating efficiency over older model furnaces by 40%.
- Ceramic fans of one piece, super-alloyed construction which can be used at temperatures beyond 2000°F.

Call your nearest Ipsen office for a copy of Bulletin T-19-C, "The facts on new Ipsen automatic heat treating units"

AUTOMATIC Ipsen HEAT TREATING UNITS

IPSEN INDUSTRIES, INC. • 733 S. MAIN STREET • ROCKFORD, ILLINOIS

For further information circle No. 67

NEWS TO HEAT TREATERS...

M.T.I. ACTIVITIES

The Annual Meeting of the Metal Treating Institute will be held at the Hotel Sheraton-Towers, Chicago, on November 5, 6, and 7. This will be the 46th consecutive meeting of the Institute.

One of the outstanding features of the 3-day meeting will be the participation by the members of the Institute in a jointly-sponsored technical session on "Heat Treating" which will be part of the 41st National Metal Exposition and Congress.

The second day of the Meeting will feature two speakers: I. Austin Kelly III, National Employee Relation Institute, Inc., will speak on the subject "Pension and Profit-Sharing Programs;" and the second speaker will be Mr. Robert S. Day, Leeds & Northrup Company, Philadelphia, Pa., who will speak on the subject "The Extent and Value of Accuracy in Instrumentation During Heat Treatment."

Friday evening will feature the Annual reception, banquet, and Floor Show with dancing in the Tally-Ho Room of the Hotel Sheraton-Towers. The meeting will conclude on Saturday morning with the General Business Meeting and the Election of Officers.

MTI-ASM HEAT TREATING SESSION

Members of the Metal Treating Institute are participating for the second time this year in a jointly-sponsored technical session as part of the 41st National Metal Exposition and Congress being held in Chicago during the week of November 2-6.

The technical session on the morning of Thursday, November 5, in the Hotel Sherman will be devoted to the subject of "Heat Treating," and members of the MTI are scheduled to present the following papers:

"Carbon Control During Heat Treatment" . . . By Robert W. Krogh, Ipsenlab of Rockford, Rockford, Ill.

"Heat Treating Specifications—a Few Weak Spots" . . . By Lou J. Haga, State Heat Treat, Inc., Grand Rapids, Mich.

"Heat Treatment of Gears," a panel discussion, will be led by K. U. Jenks, Lindberg Steel Treating Company, Melrose Park, Ill. and President of the MTI. He will serve as Chairman and Moderator. Members of the panel and their subjects are: ". . . by Furnace and Induction," by N. O. Kates, Lindberg Steel Treating Co., Melrose Park, Ill.; ". . . by Flame," by J. T. Howat, Pittsburgh Metal Processing Co., Inc., Pittsburgh, Pa.; ". . . by Nitriding," by Horace C. Knerr, Metlab Co., Philadelphia, Pa.; and ". . . by Salt Bath," by M. Soviak, Commercial Treating Corp., Detroit, Mich.

NEW PRESIDENT

The Board of Directors of Commonwealth Industries, Inc., Detroit, Mich., has just announced that C. R. Weir has been named the new President of the company.

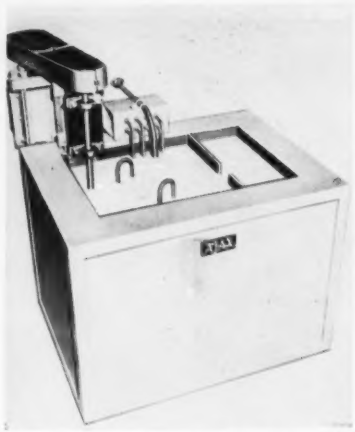
At the same time Mr. Charles G. Heilman, who had been President, was named Chairman of the Board.

Prior to his new position, Mr. Weir had been the Vice President of the company and is currently the Vice President of the Metal Treating Institute.

ISOTHERMAL QUENCH TV AT METAL SHOW

Operating features of the Ajax salt bath Cataract Quench furnace will be demonstrated on closed circuit television at the Ajax Electric Company's booth No. 1526 at the Metal Show.

Said to be "the most versatile quench ever built," the furnace offers any needed quench flow velocity "from nothing to Niagara" at the turn of a crank. This ultra-critical control paves the way to quenching results previously unobtainable and is believed to assure



meeting practically any T-T-T curve requirement with precision. Results are readily reproducible. Work of almost any shape or size can be handled. It produces uniform hardness, elimination of quench cracks, and negligible distortion.

The unit has an internal heating system to bring the salt quickly up to operating temperature. Once the furnace is in operation, forced air circulation between the pot and casing wall helps dissipate heat from the work. Circulation of the molten salt is concentrated in the work area of the bath.

For further information circle No. 1

TEMPERATURE INDICATING MATERIALS EXHIBIT

The expanded line of Tempil ° temperature indicating materials will be displayed in Booth 225 at the National Metal Exposition in Chicago.

The Tempil Corporation, New York, has developed Tempilstiks ° and Tempilaq ° for 2300°, 2400° and 2500° F as part of its temperature indicating materials.

For further information circle No. 2

(Continued on page 26)

Your Source of Quality Heat Treating Materials and Personalized "On-the-job Service"

The next time you're faced with a difficult and costly heat treating problem, call in the man whose training and experience qualifies him as "the man with the answers": your local representative of the Park Chemical Company. As a representative of Park Chemical, for 45 years producers of a complete line of quality heat treating materials, your Park man will help you decide which materials and methods are best suited to smooth out your heat treating operations.

Carburizing or hardening, heating or quenching, whatever the operation may be, the Park man will show you the Park product that will result in more efficient, less costly heat treating. On-the-job tests in plants all over the country have proven that Park heat treating materials mean less rejects, better finishes, and virtual elimination of production tie-ups.

Whenever a difficult heat treating operation threatens to tie-up your production, call in the Park man for on-the-job help. He's always available. Call him, or write us direct.

Solving Heat Treating Problems Since 1911

Park

PARK CHEMICAL CO.
8074 Military Avenue • Detroit 4, Michigan
Phone: TYler 5-7215

PHILADELPHIA BRANCH PLANT
3031 N. Melvale Street
Phone: GArfield 6-6030

Visit us at Booth 723 at the Metal Show in Chicago November 2nd to 6th

REPRESENTATIVES

DETROIT—C. R. Foreman, W. P. Askew, L. S. Woodside
CLEVELAND—R. W. Cameron, 19106 Shakerwood Road, Phone: LOngacre 1-8072
CHICAGO—M. J. Vandenberg, 2008 W. 102nd Street, Phone: CEdarcrest 3-7135
EAST LANSING, MICH.—R. Hammerstein, 1015 Northlawn, Phone: EDgewood 2-3926
CINCINNATI—James F. Hetz, 1313 Mimosa Lane, Phone: GRandview 1-3145
LYNNFIELD CENTER, MASS.—R. H. Settles, 651 Lowell St., Phone: 4-3390
PHILADELPHIA—T. J. Clark, 7240 Lawndale St., Phone: PIlgrim 5-6562

AGENTS

HOUSTON—M. K. Griggs Co., Phone: CApitol 8-2261—7-5523
DALLAS—M. K. Griggs Co., Phone: WHithall 1-4994
TULSA—Kimball Chemical Co., Phone: GIbson 7-0168
KANSAS CITY—Industrial Electro. Gas Equip. Co., Phone: BE 1-3317
MINNEAPOLIS—Hawkins Chemical Co., Phone: FEderal 9-7246
DENVER—T. C. Jarrett Co., Phone: BElmont 3-2333

LICENSED MANUFACTURERS

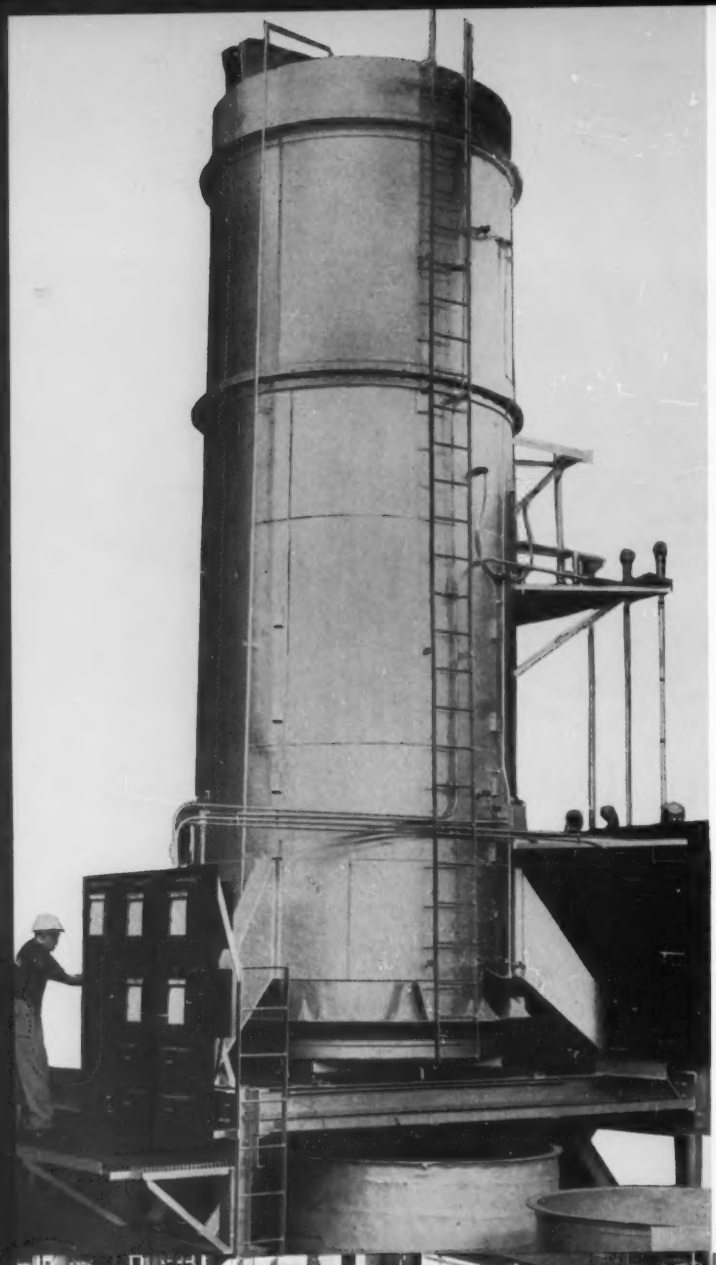
Electric Resistance Furnace Co., Ltd.
Netherby, 161 Queens Road
Weybridge, Surrey, England

Elto—Lindberg Ltd.
15 Pelham Avenue
Toronto 9, Ontario
ROger 6-6456

Park Italiana
Via Giampiero Lucini 21
Milano, Italy

California Alloy Products Co.
6438 E. Corvette St.
Los Angeles 22, California
Phone: RAymond 3-6487

For further information circle No. 66



HAVE YOU A HEAT TREATING PROBLEM?

Take it to your Commercial Heat Treater for:

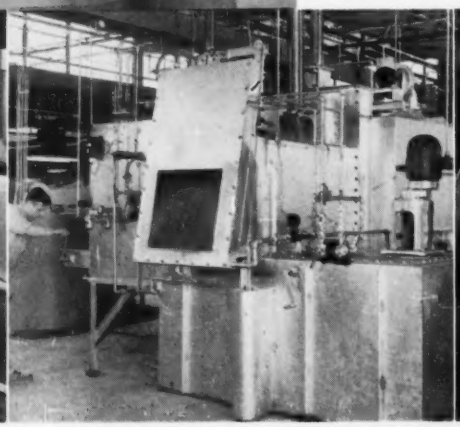
DESIGN: Technical advice about the *design* of met parts requiring heat treating.

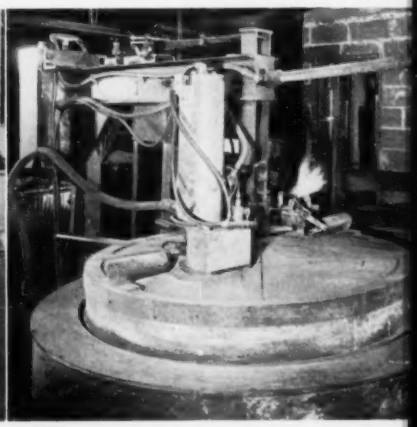
PROCESS: Facts as to the correct heat treati *process* required to achieve service requirements.

EQUIPMENT: The variety of modern specialize *equipment* needed for efficient cost saving oper tions.

SKILLS: The operational *skills* developed by years experience in all phases of ferrous and non-ferro metal treatments.

All these add up to SERVICE –the type of service only the Commercial Heat Treater can provide.





Consult your Commercial Heat Treater about your design or specification problems

ALABAMA

Southern Metal Treating Co., Inc.
3131 10th Ave. N., Birmingham 4

CALIFORNIA

Certified Steel Treating Co.
2454 E. 58th St., Los Angeles 58
Lindberg Steel Treating Co.
2910 S. Sunol Drive, Los Angeles 23
Cook Induction Heating Co.
4925 East Slauson Ave., Maywood

CONNECTICUT

Commercial Metal Treating, Inc.
89 Island Brook Ave., Bridgeport 6
Stanley P. Rockwell Co.
296 Homestead Ave., Hartford 12
Ireland Heat Treating Co.
512 Boston Post Road, Orange

ILLINOIS

Accurate Steel Treating Co.
2226 W. Hubbard St., Chicago 12
Allied Metal Treating Corp. of Illinois
333 N. California Ave., Chicago 12
Dura-Hard Steel Treating Co.
2112 W. Rice Street, Chicago 22
Perfection Tool & Metal Heat Treating Co.
1756 West Hubbard St., Chicago 22
Fred A. Snow Co.
1942 West Kinzie St., Chicago 22
American Steel Treating Co.
P. O. Box 396, Crystal Lake
Lindberg Steel Treating Co.
1975 N. Ruby St., Melrose Park
Eklund Metal Treating, Inc.
721 Beacon St., Rockford
Scott & Son, Inc.
1510 First Ave., Rock Island
Ipsenlab of Rockford, Inc.
2125 Kishwaukee Street, Rockford
O. T. Muehlemeyer Heat Treating Co.
1500 Preston St., Rockford

INDIANA

Quality Steel Treating Company
1630 Locust Street, Anderson

MASSACHUSETTS

Kinetics Corporation
2 Churchill Road, Hingham
Porter Forge & Furnace, Inc.
74 Foley St., Somerville 43
New England Metallurgical Corp.
475 Dorchester Ave., South Boston 27
Springfield Heat Treating Corp.
99 Margaret Street, Springfield
Greenman Steel Treating Co.
284 Grove St., Worcester 5

MICHIGAN

Bosworth Steel Treating Co.
18174 West Chicago Blvd., Detroit 28
Commercial Steel Treating Corp.
6100 Tireman Ave., Detroit 4
Commonwealth Industries, Inc.
5922 Commonwealth Ave., Detroit 8
Vincent Steel Process
2424 Bellevue Ave., Detroit 7
State Heat Treat, Inc.
520 32nd Street, S. E., Grand Rapids 8
Royal Oak Heat Treat, Inc.
21419 Dequindre, Hazel Park
American Metal Processing Co.
12000 East Nine Mile Road, Warren

MINNESOTA

Metallurgical, Inc.
900 East Hennepin, Minneapolis 14

MISSOURI

Metallurgical, Inc.
1727 Manchester Ave., Kansas City 8
Lindberg Steel Treating Co.
650 East Taylor Ave., St. Louis 15
Paulo Products Co.
5711 West Park Ave., St. Louis 10

NEW JERSEY

Ace Metal Treating Corp.
611 Grove St., Elizabeth 2
American Metal Treatment Co.
Spring and Lafayette Sts., Elizabeth
Benedict-Miller, Inc.
Marin Ave. & Orient Way, Lyndhurst
Bennett Heat Treating Co., Inc.
246 Raymond Boulevard, Newark 5
L-R Heat Treating Co.
107 Vesey St., Newark 5
Temperature Processing Co., Inc.
228 River Road, North Arlington

NEW YORK

Owego Heat Treat, Inc.
Rural Route 1, Apalachin
Fred Heinzelman & Sons, Inc.
138 Spring St., New York 12
Alfred Heller Heat Treating Co., Inc.
391 Pearl St., New York 38
Lindberg Steel Treating Co.
620 Buffalo Road, Rochester 11
Rochester Steel Treating Works
962 Main Street, E. Rochester 5
General Heat Treating Corporation
206 Sand Street, Syracuse 3
Syracuse Heat Treating Corp.
1223 Burnet Ave., Syracuse 3

OHIO

Queen City Steel Treating Co.
2980 Spring Grove Ave., Cincinnati 11
Ferrotherm Co.
1861 E. 65th St., Cleveland 3
Lakeside Steel Improvement Co.
5418 Lakeside Ave., Cleveland 14
George H. Porter Steel Treating Co.
1273 East 55th Street, Cleveland 3
Reliable Metallurgical Service, Inc.
3827 Lakeside Ave., Cleveland 14
Winton Heat Treating Co.
20003 Lake Road, Cleveland 16
Dayton Forging & Heat Treating Co.
2323 East First St., Dayton 3
Ohio Heat Treating Co.
1100 East Third St., Dayton 2

PENNSYLVANIA

Drever Company
Red Lion Rd. & Philmont Ave., Bethayres
Robert Wooler
Dresher
Wiedemann Machine Co.
Gulph Road, King of Prussia
J. W. Rex Co.
Eighth and Franconia Avenue, Lansdale
Lorenz & Son
1351 N. Front St., Philadelphia 22
Metlab Company
1000 E. Mermaid Lane, Philadelphia 18
Pittsburgh Commercial Heat Treating Co.
49th St., and A.V.R.R., Pittsburgh 1
Pittsburgh Metal Processing Co., Inc.
1850 Chapman Street, Pittsburgh 15

TEXAS

Dominy Heat Treating Corp.
P. O. Box 5054, Dallas
Superior Heat Treating Co., Inc.
P. O. Box 69, Fort Worth 1
United Heat Treating Company
2005 Montgomery Street, Fort Worth 7
Cook Heat Treating Co., of Texas
6233 Navigation Boulevard, Houston 11
Houston Heat Treating Company, Inc.
2100 Quitman Street, Houston 26
Lone Star Heat Treating Corp.
5212 Clinton Dr., Houston 20

WISCONSIN

Allied Metal Treating Corp.
P.O. Box 612, Milwaukee 1
Metal Treating, Inc.
720 South 16th St., Milwaukee 4
Supreme Metal Treating Co.
4440 West Mitchell St., Milwaukee 14
Thurner Heat Treating Co.
809 West National Ave., Milwaukee 4
Wisconsin Steel Treating & Blasting Co.
1114 South 41st Street, Milwaukee 15
Harris Metals Treating Co.
4100 Douglas Ave., Racine

CANADA

Ipsenlab of Canada Limited
27 Bermondsey Road, Toronto 16, Ont.

For further information circle No. 61

All of the above listed firms are members of the

METAL TREATING INSTITUTE

271 North Avenue, New Rochelle, N. Y.

MTI MASTER CRAFTSMEN METAL TREATING INSTITUTE

NEWS TO HEAT TREATERS

(Continued from page 22)

HARDNESS TESTING EXHIBIT

The newest advances and techniques in the science of testing for quality control and the determination of hardness of materials, metals and their alloys will be demonstrated in Booth 953 by the Wilson Mechanical Instrument Division, American Chain & Cable Company, Inc., Bridgeport, Conn., at this year's National Metal Exposition. This show will convene at the International Amphitheatre, Chicago, from November 2-6.

Wilson, makers of a complete line of Rockwell hardness testers and Rockwell microhardness testers for laboratory and mass production work, will introduce a completely new and highly efficient microhardness tester which has been designated as the Model "LL". (See photo).

Mr. V. E. Lysaght, general sales manager, has stated that "this new, economical, semi-automatic unit with a relatively selective range of indentation loads from 25 to 1,000 grams, has the ability to check work with ease and reliability." It will greatly facilitate the testing of cutting tool carbide tips, watch springs, drill rods, instrument pivots, surgical needles, plated surfaces, etc.

For further information circle No. 3

REVOLUTIONARY NEW CONCEPT IN ANNEALING

Lee Wilson Engineering Co., Cleveland, has developed a revolutionary new heat treating procedure with their opened coil recuperative annealing process.

Their opened coil annealing system is said to set new standards in heating speeds and temperature uniformity, and comparative cost analyses reveal reductions in over-all costs of at least $2.00 per ton with an average capacity of 20 tons of uniformly annealed product per hour.

The heart of the new system is reported to be in the method used to open tight coils coming from the cold reducing mill and then rewinding them into final tight form after heat treating. The tightly-rolled coil is placed on the recoiling mechanism and the coil is then rewound into an open form by inserting a nylon string at the top edge of the laminations. (See cut).

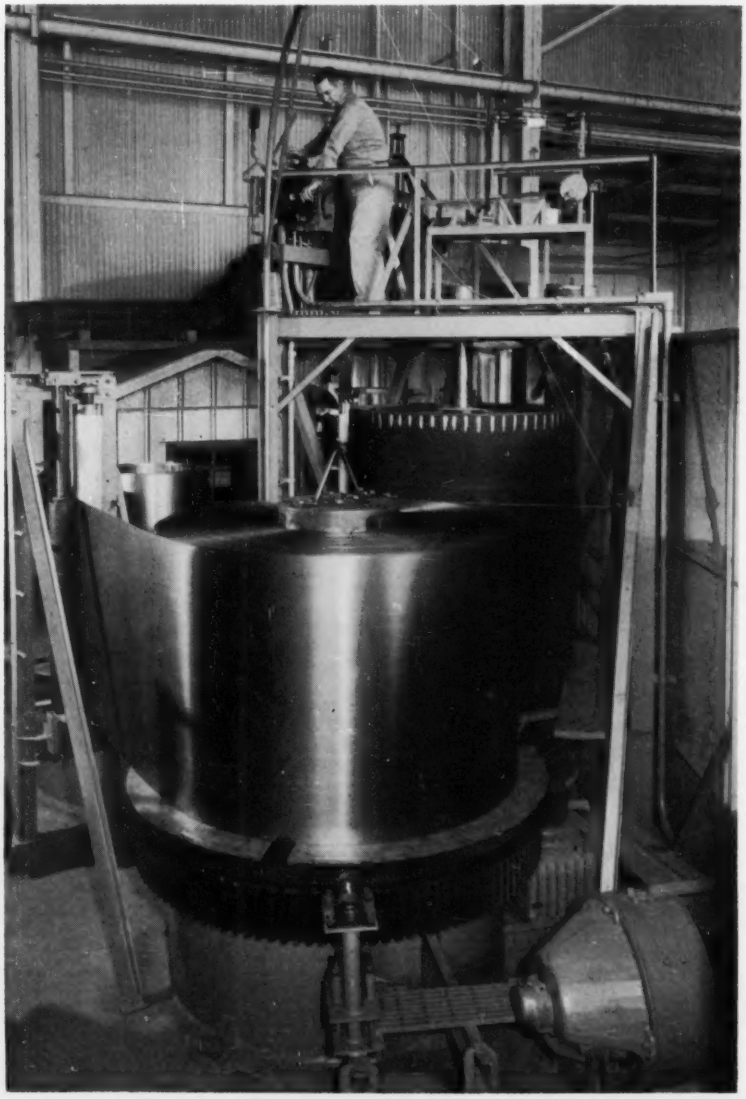
In its expanded form the space between laminations is approximately 100 per cent of the steel gauge. Thus, heated atmosphere gases can circulate freely over both surfaces of each lamination.

A 4-color, 6-page illustrated booklet describing the new annealing system with schematic diagrams is available.

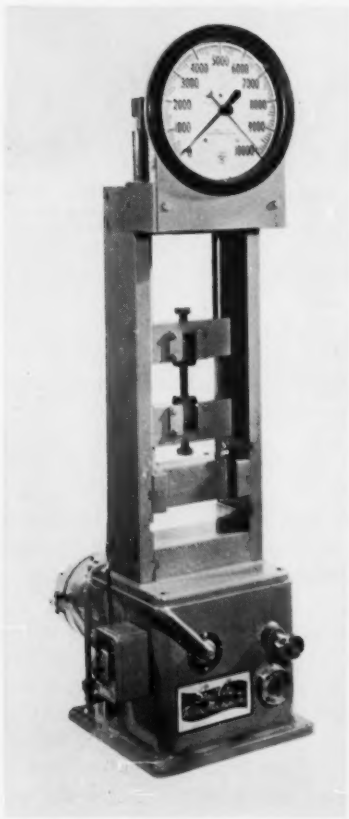
For further information circle No. 4

TENSILE TESTING EXHIBIT

Equipment never before exhibited at the Metal Show will be featured by Steel City Testing Machines, Inc., Detroit, in Booth No. 1727.



Highlights of the exhibit will be two completely new tensile testing machines. One is a bench-mounted model (see cut), and the other is portable. Both of these testing machines have several accessory sizes and styles of specimen-holding jaws



so they cover a wide range of flat and cylindrical specimens. Maximum capacities of these models range from 1000 to 40,000 lb.

For further information circle No. 5

VACUUM MELTING, SINTERING, AND HEAT-TREATING EXHIBIT

Sintering, heat-treating, or degassing at temperatures up to 2200° C (4000° F) can be carried out in the Model 435-582 cold-wall vacuum furnace developed by F. J. Stokes Corporation, Philadelphia, which will be exhibited (in Space 542) at the National Metal Show.

Also on display will be a Model 437-520 vacuum melting and precision casting furnace for the preparation of small quantities (5 to 17 lbs.) of high-purity metals and the production of precision-contour parts by investment casting or permanent-mold casting techniques, and a Model 1710 mechanical booster vacuum pump (1100 cfm. capacity) for the rapid evacuation of large spaces.

For further information circle No. 6

LUCIFER CHIEF ENGINEER

Clement Dinon, President of Lucifer Furnaces, Inc., Neshaminy, Pa., has announced the appointment of John J. Shingle as Chief Engineer.

CERAMIC ENGINEER

Appointment of Ralph Allison as Chief Ceramic Engineer for the Zero Refractories Division of Standard Fuel Engineering Co., Detroit, has been announced by G. Howard Willett, President.

METALLURGICAL EDITOR

Edward N. Case has been named Metallurgical Editor for *Steel* magazine, it was announced recently.

Before joining *Steel*, Mr. Case was sales and advertising manager at Ajax Electric Co., Philadelphia, and also served on its board of directors. Previously, he was supervisor of the metal chemicals section of the American Cyanamid Co.,

(Continued on page 39)

(Continued from page 11)

of these greatly assists in obtaining sound joints. By now, vacuum had begun to assume part of the work load that had been handled previously in atmosphere furnaces. (See Fig. 4).

In late 1957 they were again plagued by the necessity for still higher temperatures. Furthermore, equipment that would come up to temperature rapidly and cool rapidly was needed to handle thin materials and prevent or reduce solution or penetration. The answer was the internally-heated furnace with cold walls. The thermal mass of the retort would be eliminated and higher temperatures attainable. Working in conjunction with the parent organization, Kinetics developed an elevator-type furnace capable of 3100°F operation that could be converted to 4500°F operation at a later date.

Early in 1958, they installed a new furnace for gas quenching and adapted the two 36″ x 36″ units for the same purpose. They could now perform a brazing operation and do precipitation hardening in one operation.

Several months later they installed another vacuum furnace capable of performing heat treating or brazing operations and equipped with an oil quenching chamber. Also by the end of 1958, High Vacuum Equipment Corporation completed design work on a 36″ x 36″ elevator-type, internally-heated furnace for 3100°F operation. It can be modified later for operation to 4000°F. (See Fig. 5).

In four short years then, we have seen temperature requirements rise from 1650°F to a presently forseeable 4000°F. Cooling requirements have gone from slow radiation cooling in vacuum to water or oil quenching.

As you may conclude from this discussion, the equipment at Kinetics has an extremely high rate of obsolescence. Generally, this would not be tolerated by industry, but because of Kinetics' affiliation with the parent organization, it is economically practical. It serves as a proving ground for prototype furnaces operating under true production conditions, thereby providing the empirical data required for future equipment designs.

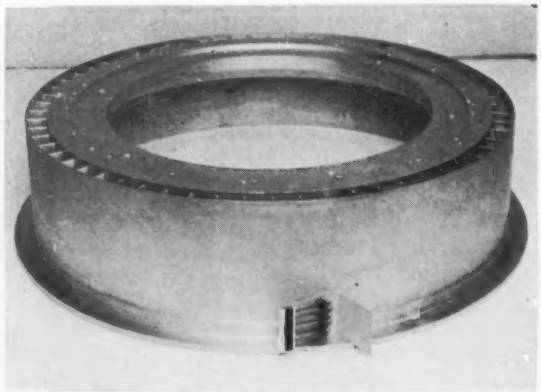


Fig. 4—An aircraft gas turbine diffuser vane and shroud assembly fabricated of Type 4130 moly steel. The inner ring and vanes were machined from a solid forging. This in turn was vacuum brazed to the relatively thin shroud assembly at 2100°F, using AMS 4775 filler metal (chrome, nickel, silicon, boron, iron). Due to the several sections of dissimilar mass, development of very carefully controlled heating and cooling cycles was necessary.

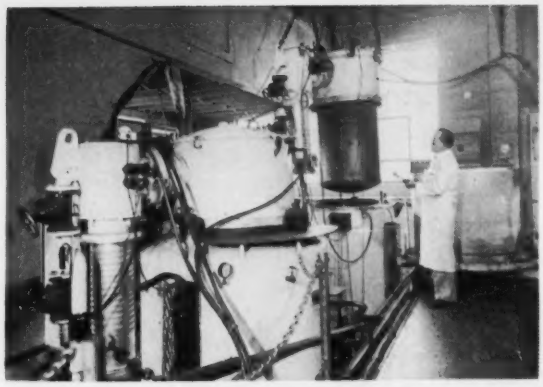


Fig. 5—A section of Kinetics' high vacuum processing facility showing two of the larger furnaces capable of sustained operation at 2150°F while maintaining pressures on the order of 3 x 10^{-5} mm Hg.

By operating as a development, pilot, and production facility for its customers, it establishes their requirements for production equipment with no capital expense. The range of equipment is sufficient in scope to meet most requirements for brazing, heat treating, and annealing.

Equipment of this type is capable of being operated by unskilled or semi-skilled labor. The only requirement for trained personnel is in the establishment of processing specifications. While the operation of furnaces using prepared atmospheres requires a knowledge of chemistry, a vacuum furnace requires a knowledge of basic physics. Furthermore, the results are readily reproducible.

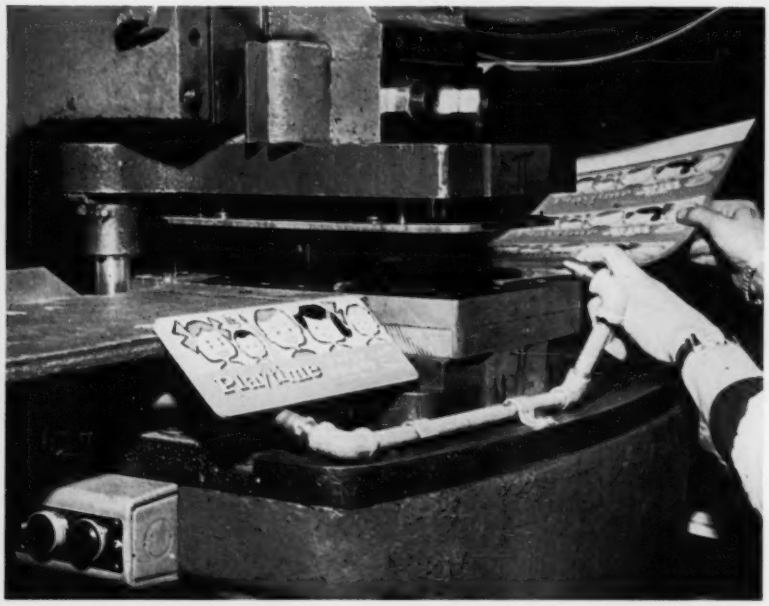
Present-day costs for vacuum processing are quite competitive with atmosphere processing. As an example, a titanium compressor blade for a jet engine can be stress relieved and degassed for as little as 35¢. However, costs will not become really competitive until equipment can be operated on a continuous or semi-continuous basis. Some steps have been taken in this direction by construction of semi-continuous furnaces for annealing and degassing tubing. This is accomplished by having a loading zone, a heating zone, and a cooling zone with water-cooled gate valves between each zone. Truly continuous furnaces for annealing strip materials where the strip enters the heated furnace through differentially pumped locks and leaves the furnace by the same means are presently under consideration.

In conclusion, we predict that the rapid technological progress being made by the world's metallurgists with the super alloys and refractory metals presages a bright future for the commercial vacuum heat treat plant. • • •

Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation



Lehigh H Teams Up with Brake Die

Result: 150,000 Box Tops

The job was a tricky one. It called for the blanking and forming of .010-in. black plate into hinged tops for children's paint boxes. But with the black plate already lithographed, it was imperative to avoid marring the material.

The manufacturer, Sobel Metal Products Co., Easton, Pa., talked it over with his local Bethlehem tool steel distributor, Luria Steel Supply Co., Catasauqua, Pa. The Luria representative proposed the use of Lehigh H for the die, and Brake Die for the punch. This proved a wise choice, for combined, the two tool steel grades turned out 150,000 pieces without any need for redressing. And the black plate received nary a scratch.

Bethlehem Lehigh H (AISI D-2) is our easy machining high-carbon, high-chrome tool steel. It is an air-hardening grade, with plenty of wear-resistance thanks to its excellent carbide distribution. Brake Die, a grade of special analysis steel, is oil quenched and tempered to develop the mechanical properties needed for maximum wear and toughness.

Bethlehem regularly produces about 30 different grades of tool steel—a range so wide as to meet virtually every requirement. For full information, call your Bethlehem tool steel distributor.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Hot-Work Tools Last Longer When Thermal Stress Is Reduced

Deterioration of hot-work tools in service by heat checking or cracking depends largely on the severity of thermal stress developed in service. Anything which can be done to decrease the magnitude of the thermal stress will increase the service life of the tools.

One of the most essential steps in using hot-work tools is to preheat them to their normal working temperature before use. This seemingly insignificant step will often improve the tool life appreciably because it decreases the severity of the initial stress cycles.

The provision of multiple tools which are used in succession is another simple way to decrease thermal stresses on certain types of hot-work tools. For example, on piercing operations the press may be provided with as many as six piercing punches mounted on an indexing fixture. After each piercing operation a different punch is moved into position for the next operation. This permits each punch to cool during the time of the next five operations, greatly reducing the severity of thermal stress. The service life of punches used in this manner is often twice that of punches used continuously in the same operation.

Air-4 hardens in air at 1550F.

With AIR-4 You Get Air-Hardening at Low Temperatures . . . FREE MACHINING . . . EXCELLENT WEAR

Air-4, Bethlehem's new medium-alloy tool steel, hardens in air at 1550F, and has excellent free-machining properties due to its carefully controlled addition of lead. It has exceptional wear-resistance and high toughness. Moreover, it can be heat-treated with complete freedom from the dangers of cracking. Ask your Bethlehem tool steel distributor for complete information on Air-4.

For further information circle No. 63

(Continued from page 3)

factors to be considered. The *overall* cost of producing an article should be the guide, not the cost per heat unit. Where the article is expensive to make, any reduction in spoilage or simplification in the process may be several times greater than the entire fuel cost.

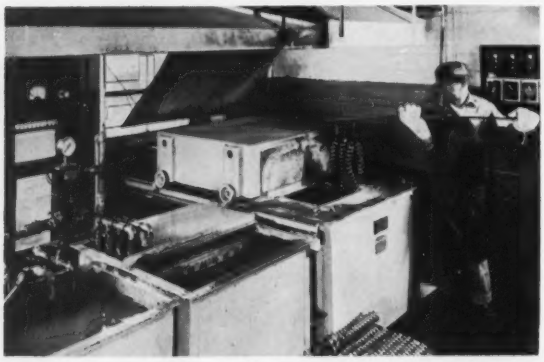


Fig. 4—G. H. Leland Co.'s installation for carburizing, brazing and hardening of miscellaneous stampings.

For these reasons, the electrode salt bath furnaces have far outstripped directly competing furnaces, and have in fact in many cases outperformed the more conventional methods. A few examples will serve to illustrate this fact:

Two steel stampings, forming part of a rotary solenoid type switch manufactured by the G. H. Leland Company of Dayton, Ohio, and shown in Fig. 3. which were previously copper brazed in a belt type furnace, are now both carburized, brass brazed and hardened in a single operation with a cost reduction of 83.5%, from $79.00 to $13.11 per 1000 pieces. The installation is shown in Fig. 4.

Fig. 5—Monarch "Silver King" bicycle fork brazing equipment. 240 forks per hour.

A second example covers the brazing of bicycle forks. There are five installations in America where this operation is performed, some of which are mechanized.

The Monarch Silver King Company of Chicago, Illinois, reported the following cost reductions:

When changing from hand dipping in molten brass pots to salt bath dip brazing, production increased from 1200 forks in 16 hours to 1400 forks in 6 hours with a cost reduction of seven cents per unit. The installation is shown in Fig. 5.

Types of Dip Brazing Applications

The type of work which is being produced by dip brazing can be grouped as follows:

1) Brazing of magnesium and aluminum alloys between 485° C (900° F) and 620° C (1150° F).

2) Brazing of ferrous and non-ferrous assemblies with silver solders between 675° C (1250° F) and 950° C (1750° F).

3) Brazing of copper with self-fluxing brazing alloys containing phosphorous between 800°C (1500°F) and 870°C (1600°F).

4) Brazing of ferrous assemblies with brass and bronze alloys in self-fluxing bath containing cyanide between 910°C (1675°F) and 950°C (1750°F).

5) Brazing of ferrous assemblies with special nickel containing alloys between 980°C (1800°F) and 1200° C (2200°F).

6) Brazing of ferrous assemblies with copper at 1120° C (2050° F).

The possibilities cover, therefore, almost the entire range of metals and of brazing alloys in common use.

A summary of the types of salts in current use is shown in Table I. Some of these are common heat treating salts and some are proprietary patented compositions. Likewise, some of the brazing alloys which are available are listed in Table II, with their general composition. Many are known by their trade names, and the exact formula is not available. Practically all, however, have been thoroughly tested through extensive laboratory and field investigations and can be relied upon to give consistent results. These are available in the form of wire of various sizes, in shim stock, in sheet form. They can be purchased in prefabricated form such as rings or loops, washers, discs, etc. They are also available in the form of powder, although until recently the application of the alloy in the form of paint was not practical in a salt bath furnace.

It is quite possible for the brazing material to reach and to exceed its melting point before the balance of the assembly has been heated sufficiently to promote the wetting action. When this occurs, the alloy is lost and no brazing takes place. For this reason, it is almost always preferable to design the assembly in such a way that the brazing alloy will be internal to the article. It will be located in grooves, recesses, drilled holes, etc. The clearance between joints varies widely but generally is of the order of .001" to .003". Interference fits are generally unacceptable except for copper. Good filleting is obtainable. Common practice on this point is shown in Table III.

(Continued on page 34)

Pacific

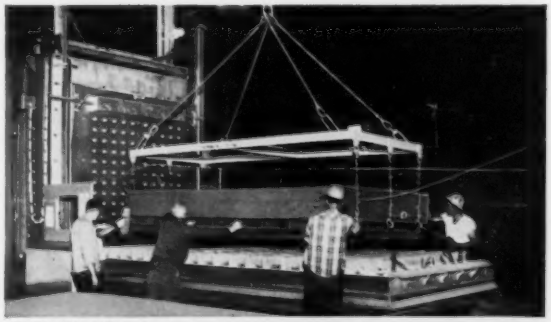
CAR-BOTTOM FURNACE** DESIGNED AND BUILT BY PACIFIC, HELPS PRODUCE WORLD'S LARGEST STAINLESS STEEL HONEYCOMB SANDWICH PANEL*!

Proving that honeycomb can be made in panels much larger than previously thought possible, Rohr Aircraft has completed by far the largest stainless steel honeycomb sandwich ever produced. The big panel measures 6 by 12 feet! This means airframe designers will be able to employ honeycomb in many larger configurations and not be hampered, for all practical purposes, by size limitations.

Production was made possible by Pacific's specially designed car-bottom high-temperature, atmosphere-tight brazing furnace . . . the largest of its kind. Inside working dimensions of the Pacific furnace are 7 by 7 by 16 feet . . . ample room for even larger panels! It fully meets all the exacting requirements for honeycomb brazing and heat treating, including extreme uniformity of temperature. All-welded retorts may be used with the furnace, and provision is made for vacuum and atmosphere lines from retort to external components.

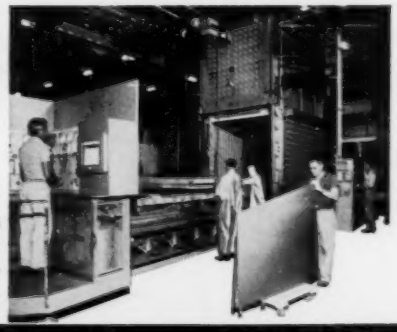
Also used for brazing panels for the B-58 Hustler, the big furnace is but one of many special furnaces that Pacific has designed and built to provide faster, more efficient production of stainless steel honeycomb. If your requirements call for a special furnace such as this or a standard design furnace, Pacific can be of service to you. For specific information call or write Pacific Scientific Company today!

- Panel dimensions — 6' x 12' x 1"
- Square cell core and skin — AM-350 SS
- Bar stock — AM-355
- Brazing alloy — silver-copper-lithium
- Brazing temperature 1650°F.
- Atmosphere-argon



DESIGN FEATURES FOR MORE EFFICIENT, MORE ECONOMICAL OPERATION:

- Cam profiled ways insure smooth action, gas-tight door
- Air operated door
- Alloy capped car piers for flat working surface for retort
- Multiple zone control
- Heating elements on all side walls, door and car hearth
- Temperatures from 900°F. to 2200°F.
- Uses any protective atmosphere including hydrogen



Pacific

TRADE MARK

GAS OR ELECTRIC INDUSTRIAL HEAT TREATING EQUIPMENT

PACIFIC SCIENTIFIC COMPANY

LOS ANGELES
SAN FRANCISCO
SEATTLE
PORTLAND, OREGON
ARLINGTON, TEXAS
SAN DIEGO

CREATIVE DEVELOPMENT AND MANUFACTURING IN FURNACE DESIGN

PACIFIC SCIENTIFIC COMPANY • P. O. Box 22019, Los Angeles 22, Calif.

☐ Please send me information on custom designed furnaces ☐ Please send me your FREE Brazing Catalog ☐ Please send me a copy of your new catalog and full information on Pacific Heat Treating Equipment

Name _____

Company _____

Address _____

City _____ Zone ____ State _____

ALL TOP PERFORMERS!

. . . "set the tempo" for modern heat treating.

The precision quenching possible with Houghton Mar-Temp Salts prevents distortion and cracking, yet insures the strength and hardening accuracy necessary for precise performance and reliability.

. . . there's one to "harmonize" with your production processes.

A full line of cleaners to speed and simplify industrial metal cleaning of all types. Includes Houghto-Clean 313-A, a pre-finish metal cleaner that cuts cleaning time and costs and eliminates need for special acid-resisting equipment.

. . . most famous names in rust prevention . . . "in tune with the times".

Featuring polarized Rust Veto 377—the economical, effective indoor rust preventive that protects whether metal is dry or wet—actually raises water off metal to form a long-lasting protective film under the moisture. Effective, without staining, on all types of metal for as long as a year.

Get the full story on these all-star performers plus many oldtime Houghton favorites. Also, get the new Salt Bath Handbook, ready at Metal Show time. Call or write E. F. Houghton & Co., 303 W. Lehigh Avenue, Philadelphia 33, Pa.

products of . . .

E. F. HOUGHTON & CO.

Ready to give you on-the-job service

Philadelphia • Chicago Carrollton, Ga. • Detroit • San Francisco • Toronto, Canada

DIP BRAZING

(Continued from page 30)

Table I—Salts Used for Dip Brazing.

Application	General composition	Melting point	Operating range	Remarks
Aluminum Brazing	3 Na F · AlF_3 AlF NaCl, KCl & LiCl (Proprietary Salt)	900- 1000 °F	1030- 1190 F	Fluxing Salt Ceramic Pot
Magnesium Brazing	Composition not published (Proprietary)	900 °F	1000- 1150 °F	Fluxing Salt Ceramic Pot
Silver Solder Brazing	NaCl + KCl	1230 °F	1350- 1600 °F	Neutral Salt Ceramic Pot
	$BaCl_2$ + NaCl + KCl	1020 °F	1150- 1750 °F	Neutral Salt Ceramic Pot
	Na_2CO_3 + KCl	1090 °F	1200- 1550 °F	Neutral Salt Metal Pot
	Na_2CO_3 + KCl + NaCN	1090 °F	1200- 1550 °F	Neutral Salt Metal Pot
Silver Phosphorous & Copper Phosphorous Brazing of copper assemblies	NaCl + KCl	1230 °F	1350- 1600 °F	Self Fluxing Alloy
	$BaCl_2$ + NaCl + KCl	1020 °F	1150- 1750 °F	Neutral Salt Ceramic Pot
Brass Brazing (60% Cu, 40% Zn)	$BaCl_2$ + NaCl	1150- 1450 °F	1700- 1850 °F	Neutral Salt Ceramic Pot
	($BaCl_2$ + NaCl + Borax)	1450 °F	1850 °F	Fluxing Salt
Brass Brazing & Carburizing	Conventional cyanide type carburizing salts	1100 °F	1650- 1750 °F	Carburizing Metal pot Fluxing Salt
« Nicro » Brazing	$BaCl_2$ + NaCl	1550 °F	1700- 2150 °F	Neutral Salt Ceramic Pot
	$BaCl_2$	1790 °F	2000- 2200 °F	Ceramic Pot
Copper Brazing	$BaCl_2$ + NaCl	1550 °F	1700- 2150 °F	Neutral Salt Ceramic Pot
	$BaCl_2$	1780 °F	2000- 2200 °F	Ceramic Pot

One of the important aspects of salt bath brazing is that it permits the use of certain alloys which are not practical in atmosphere brazing because of their decomposition if held at elevated temperatures for too long a period of time. Alloys of copper and zinc, such as brasses and bronzes, with as much as 40% zinc, are commonly and very successfully used in salt bath furnace brazing with strength of joint comparing favorably to copper. With these alloys considerable variation in joint clearance is permissible with little penalty in strength. For instance, variation of as much as .002" in clearance results in strength variation of only 3,000 pounds between 43,000 to 46,000 per square inch. Similar alloys are coming into use for joining of stainless steels.

Time will not permit a discussion of all the applications in use today. Because of the very rapid expansion of the uses of aluminum, both in commercial, aviation and electronic items, and the need of complex and very accurate assemblies demanded by these industries, we will select aluminum dip brazing for a more detailed discussion of the process.

The operation of an aluminum brazing bath is quite different from the ordinary one and it may be of interest to discuss this more fully.

Since it is a fluxing bath intended to remove all surface impurities from the areas of the joint, we need a salt containing strong fluorides to do it effectively. The general composition of the salt used is shown in Table I. The salt is highly hydroscopic and will pick up water from the air, even in the fused condition. It will attack and etch aluminum quite readily when it contains water, and for this reason the bath must be thoroughly dehydrated before it can be used for brazing. This is accomplished by loading into it coils of pure aluminum sheets which remain in the bath until the visible reaction stops. This is repeated till no reaction is evident with a clean coil. The original aluminum coils are reused after an etching treatment in a

Table II—Brazing Alloys Used in Dip Brazing.

Silver
(For use with steel, stainless steel, high speed steel, copper, brass)

Composition							Designation	Melting point °F	Brazing temperature °F minimum
Ag.	Cu.	Zn.	Cd.	Ni.	P.	Mn.			
50	15½	16½	18	—	—	—	AMS-4770-B	1160	1300 - 1350
50	15½	15½	16	3	—	—		1170	1350 - 1375
45	15	16	24	—	—	—		1125	1300 - 1350
35	26	21	18	—	—	—		1125	1300 - 1350
15	80	—	—	—	5	—	(Sil-Phos)	1185	1350 - 1400
54	40	5	—	1	—	—	AMS-4772	1325	1600 - 1650
5	58	37	—	—	—	—		1575	1650 - 1700
85	—	—	—	—	—	15		1745	1850 - 1900

Brass
(For use with steels, cast irons (degraphitized), malleable iron (degraphitized)

Cu.	Zn.	Sn.	Si.	Mn.	Fe.	Ni.	P.			
58	39.17	.90	.90	.03	1	.00	—	—	1600	1650 - 1750
49	40.88	—	10	—	—	10	0.2	—	1706	1800 - 1875

Copper
(For use with steels, cast iron (degraphitized)

Commercial grade (dioxidized)		1982	2050

Phos-Copper
(For use with copper (self-fluxing)

92.5 Cu.	7.5 P	—	1320-1450	1550 - 1600

High temperature corrosion resistant brazing alloy
(Nicrobraze)
(For use with Stainless Steels, Carbon Steels, Nickel Base Alloy, Inconel, Incoloy, Nimonic, etc.)

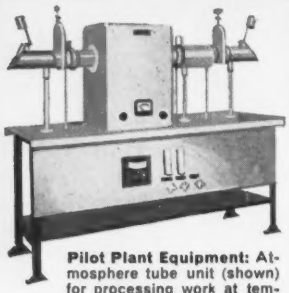
Nickel-Cromium-Boron	AMS-4775	1800° Approx.	2000 - 2200

AMS = Aeronautical Material Spec.

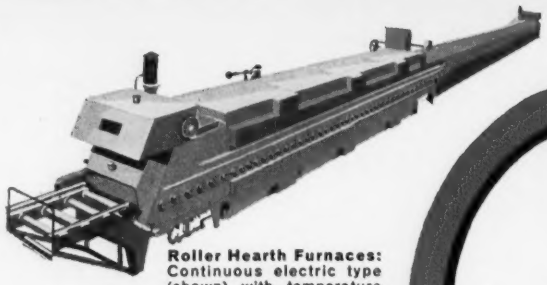
(Continued on page 38)

Wherever industry needs heat...

You'll find *LINDBERG* equipment just right for the specific job

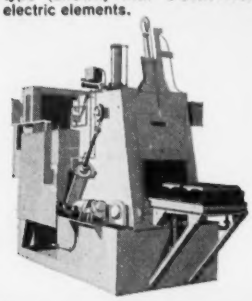


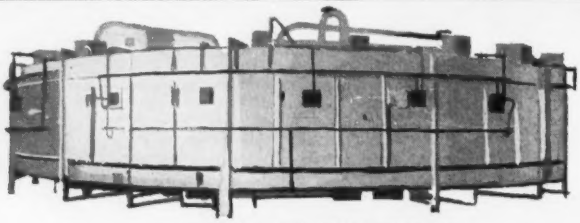
Pilot Plant Equipment: Atmosphere tube unit (shown) for processing work at temperatures to 2200° F.



Roller Hearth Furnaces: Continuous electric type (shown) with temperature range 1300° to 2100° F.

Automatic Carbonitriding Furnaces: Automated integral quench type (shown) with CORRTHERM electric elements.

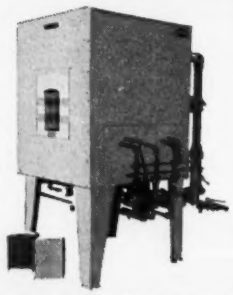




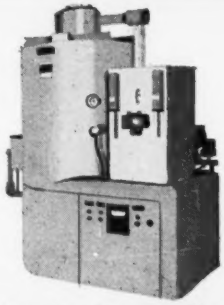
Rotary Hearth Furnaces: Doughnut type field-installed gas-fired furnace (shown) with capacity of 13,000 lbs. per hour.

Vertical Type Furnaces: Carburizing and hardening furnace (shown) with CORRTHERM electrical heating elements.

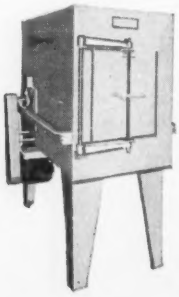
HF Induction Heating Units: Available in 5, 10, 25 and 50 KW units.



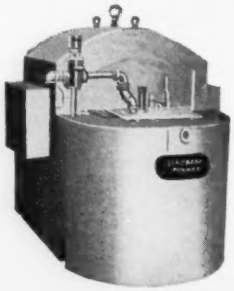
Ceramic Kilns: Gas-fired periodic kiln (shown) with temperature range to 3250° F.



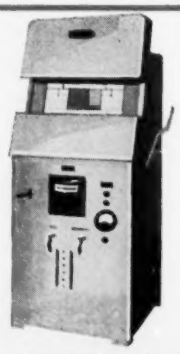
Atmosphere Generators: Hyen generator (shown) for endothermic atmospheres. Generators for all required atmospheres.



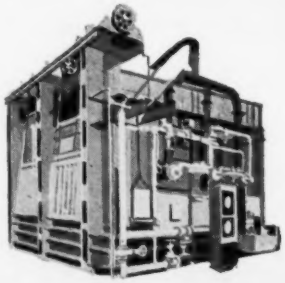
Tempering Furnaces: Box type Cyclone (shown). Temperature range to 1250° F.



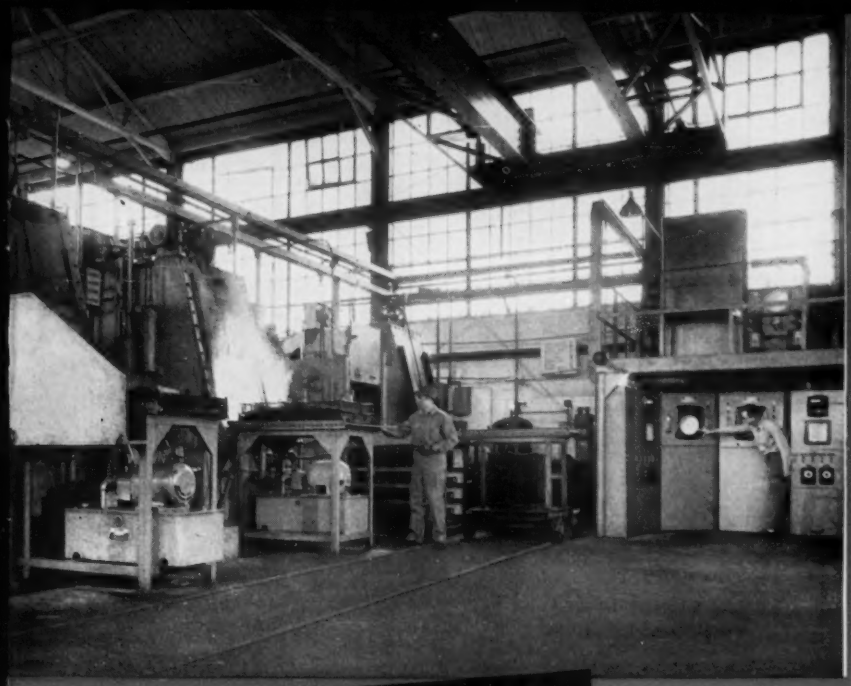
Melting and Holding Furnaces: Electric resistance furnace (shown) with capacities of 750 lbs. to 1500 lbs.



Laboratory Equipment: One-unit box furnace (shown), muffle or for non-oxidizing atmosphere with temperature range to 3000° F.



Aluminum Reverberatory Furnaces: Twin-chamber melting and holding furnace (shown) with 45,000 lbs. capacity.



Lindberg-Designed

Charles Hewitt, President of Dayton, says, "The Lindberg installation has kept our production at a consistently high quality level."

Work loads are positioned manually, but entire furnace operation is fully automatic.

Unique Installation Cuts Heat Treating Costs and Improves Quality at Dayton

Here is a remarkable set-up for general heat treating now in operation at Dayton Forging & Heat Treating Company, Dayton, Ohio. Two integral quench atmosphere furnaces, largest of this type ever built by Lindberg, and one atmosphere tempering furnace in a "three-in-a-row" arrangement that simplifies transfer operation. Combined with Lindberg Carbotrol and Hyen generator, the entire furnace operation is completely automatic, including atmosphere control and recording. Planned by Dayton and Lindberg engineers, the installation runs around the clock, six days a week, reducing costs and producing cleaner end products, brighter job finish, freedom from "decarb" and a consistently higher quality of work.

This is another example of how Lindberg equipment and Lindberg planning can help you find the most effective answer to any problem of applying heat to industry. We cover the field, heat treating, melting and holding, tempering, brazing, enameling furnaces, ceramic kilns, high frequency units, and are in the ideal position to recommend just the type of equipment most suitable for your needs. This can be factory built or field-installed in your own plant, fuel-fired or electric, whatever is best suited to your production processes. Consult your local Lindberg Field Representative (see the classified phone book) or get in touch with us direct. Lindberg Engineering Company, 2466 West Hubbard Street, Chicago 12, Illinois. Los Angeles Plant: 11937 S. Regentview Avenue, at Downey, California.

Lindberg Carbotrol unit automatically controls and records "dew point" and heating cycles of endothermic atmosphere.

Lindberg's "dimple" vertical radiant tubes give remarkably trouble-free service and function at all times at full efficiency.

heat for industry

For further information circle No. 60

DIP BRAZING

(Continued from page 35)

Table III—Joint Clearances.

Application	Clearance between mating surfaces	
	Preferred	Maximum
Aluminum	.006/.010" for joints up to 1/4" in length	.025" for joint length in excess of 1/4"
Silver Solder	.001/.003"	.006"
Brass (60-40)	.002/.006"	.010"
Brass (Nickel-Silver)	.001/.006"	.010"
Copper	.001" interference to .001" loose	.003"
Nickel - Chromium-Boron	.001/.003"	.005"

caustic bath. This operation is repeated as needed which can be as often as once a day.

In addition, the chemical balance requires periodic addition of lithium chloride to keep melting point to the proper level, and aluminum fluoride to maintain the fluxing power.

As far as the furnace itself is concerned, a ceramic pot built of brick with a high alumina silica ratio and generally double fired is invariably used. Metal pots are impractical and if used, must be iron free, since iron is a highly undesirable contaminant. Electrodes and thermocouple protective sheath should be high nickel alloys or pure nickel.

It has also been well established that the preferred salt mixture is not a eutectic but a mechanical one. It tends to segregate, with the heavier components, especially Cryolite, settling to the bottom. Despite the electromagnetic stirring obtainable with an electrode furnace, this condition may exist. For this reason, mechanical stirring devices are commonly provided, even though their use is generally intermittent.

A wide variety of aluminum alloys, both wrought and cast, are being dip brazed in the United States, both for commercial articles and for avionic and electronic purposes. Table IV shows some of the materials being brazed and Table V gives the more common brazing alloys being used. Table VI gives combinations of the two which have been proved satisfactory. The designation numbers are those assigned by Alcoa (Aluminum Company of America) in their technical data books.

There are also many designs in which it is difficult, if not impossible, to apply the brazing alloy near the joint. In that case, use is made of clad sheets in which the brazing alloy is bonded to one or both sides of the sheet, at the supplier's mill. Table VII gives the principal ones obtainable and some of their characteristics.

The brazing sheet is especially useful in the manu-

Table IV—Aluminum Alloys Suitable for Dip Brazing.

Type alloy	Brazability	Melting range °F
EC*	*A*	1195 - 1215
1100*	*A*	1190 - 1212
2002	—	
3003*	*A*	1190 - 1210
3004	*B*	1165 - 1205
5050	*B*	1160 - 1205
5052	*C*	1100 - 1200
6053**	*A*	1105 - 1205
6061**	*A*	1115 - 1205
6062**	*A*	1115 - 1205
6063**	*A*	1140 - 1205
6151	*B*	1025 - 1200
6951**	*A*	1140 - 1210
Cast 43	*A*	1065 - 1170
Cast 356	*C*	1035 - 1135
Cast 406	*A*	1190 - 1215
Cast A 612	*B*	1105 - 1195
Cast C 612	*A*	1120 - 1190

* Non-heat treatable alloys most commonly used.
** Heat-treatable alloys most commonly used.
A. Generally Brazable by all commercial procedures.
B. Brazable with special technics on applications, which justify preliminary trials or testing.
C. Limited brazability.

Table V—Aluminum Brazing Filler Metals.

Alloy designation	AWS-ASTM classification	Melting range °F	Brazing temperature range °F
4043	BA1Si-1	1070 - 1165	1105 - 1185
No. 713	BA1Si-2	1070 - 1135	1110 - 1140
No. 714	—	1070 - 1100	1080 - 1120
No. 716	BA1Si-3	970 - 1085	1080 - 1120
No 718*	BA1Si-4	1070 - 1080	1080 - 1120
No. 719	—	960 - 1040	1040 - 1080

* Most frequently used.
AWS: American Welding Society.
ASTM: American Soticety for Testing Materials.

(Continued on page 40)

(Continued from page 27)

New York, and a chemist at the A. F. Holden Co., New Haven, Conn.

Mr. Case has written a number of articles for technical journals including *Metal Treating*. Several U.S. and foreign patents on chemical processes in metalworking have been granted him.

Born in Mansfield, Ohio, he was graduated from Union College, Schenectady, N.Y., with a B.S. in chemistry in 1941. He has done graduate work in chemistry and metallurgy at Brooklyn Polytechnic Institute, Brooklyn, N.Y., and is a member of the American Society for Metals, American Chemical Society, National Sales Executives, and Sigma Chi.

ROBERTSON AT HARPER ELECTRIC

James R. Robertson has joined the sales staff of Harper Electric Furnace Corporation, Buffalo, N.Y. In his new post, he will direct the expansion of Harper activities in marketing gas-fired heat treating and non-ferrous melting furnaces.

For the past several years, Mr. Robertson has been engaged in this phase of the furnace industry as president and general manager of Wayne Industrial Furnace Company. An electrical engineering graduate of the University of Michigan, he is a former resident of Royal Oak, Michigan.

PORTABLE INSTRUMENT TESTS HEAT TREATMENT CONDITION

A transistorized conductivity-permeability meter which rapidly sorts mixed lots of metal parts is announced by Metrol, Inc., Pasadena, Calif. Trade-named "Heat-check", the instrument is used also to test quickly both ferrous and non-ferrous metal parts for such properties as heat treatment condition, relative hardness and strength, chemical purity, and presence of decarburization. Supplying information about metal structure not otherwise

(Continued on page 42)

DIP BRAZING

(Continued from page 38)

facture of heat exchangers, where very large surfaces are required for heat transfer purposes.

Recent development of a powdered aluminum filler metal in an aqueous paste has made it possible to braze many assemblies previously thought to be impossible and has materially reduced assembly time. The paste consists of a powdered filler metal (88% aluminum, 12% silicon) which is mixed with a controlled amount of flux, cement and water. The paste is applied to an assembly in the amount required. During the preheat, the cement and flux dries and serves as a binder to hold the powdered filler metal in place. Upon immersion, the binder dissolves, permitting the molten filler metal to flow and distribute itself by capillary action and gravity. Tensile strengths of up to 45,000 psi have been obtained in joints of 1/16" gap in Type 6061 aluminum. The recommended joint clearances are shown in Table III.

Parent metal	Brazing alloy	Optimum brazing temperature °F
1100 303 Cast 406	No. 4043 No. 713	1140 - 1180 1110 - 1140
No. 11 Brazing Sheet No. 12 Brazing Sheet No. 100 Brazing Sheet	No. 713	1100 - 1140
No. 23 Brazing Sheet No. 24 Brazing Sheet	No. 718	1080 - 1120
6951 6063	No. 718	1080 - 1120
Cast C-612	No. 716 No. 718 No. 719	1080 - 1120 1080 - 1120 1040 - 1080
6061 6062	No. 716 No. 718 No. 719	1080 - 1110 1080 - 1110 1040 - 1080
6053 Cast A-612	No. 716 No. 718 No. 719	1080 - 1100 1080 - 1100 1040 - 1080
Cast 43	No. 719	1040 - 1060

Table VI—Typical Parent Metal & Brazing Alloy Combinations.

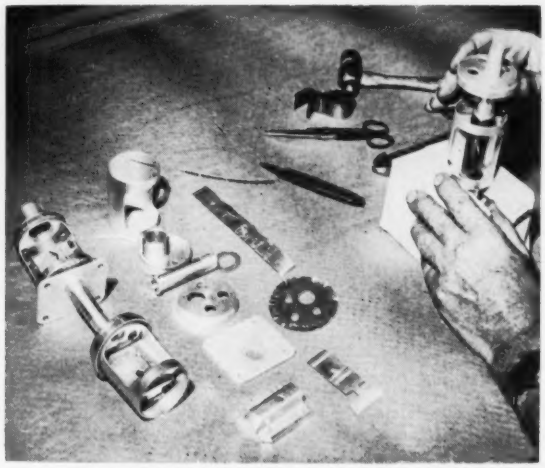


Fig. 6—Aluminum components ready for assembly.

Joint design is also a very important factor in all dip brazing applications. Due to very close tolerances that are required of electronic devices, such as microwave guides, it is essential to design as many joints as possible to be self locating. Tack or spot welding should be used only when necessary in order to avoid subsequent fatigue failure due to the welds causing stress risers and porosity. They should also be designed with adequate clearance since the brazing alloy tends to alloy with the base metal and clearance is necessary

(Continued on page 44)

Alcoa brazing sheet designation	Sides coated with brazing alloy	Core alloy	Coating composition % Silicon	Thickness	
				Sheet inches	Coating percent
No. 11	1	3003	7.5	0.063 & less	10
No. 12	2	3003	7.5	0.063 & over	5
No. 21	1	6951	7.5	0.090 & less	10
No. 22	2	6951	7.5	0.091 & over	5
No. 23	1	6951	10.0	0.090 & less	10
No. 24	2	6951	10.0	0.091 & over	5
No. 100	1	3003	7.5	0.063 & less 0.064 & over	10

Table VII—Brazing Sheets.

A BETTER PRODUCT FOR PACK HARDENING AND BOX ANNEALING...

Anneel-Pak

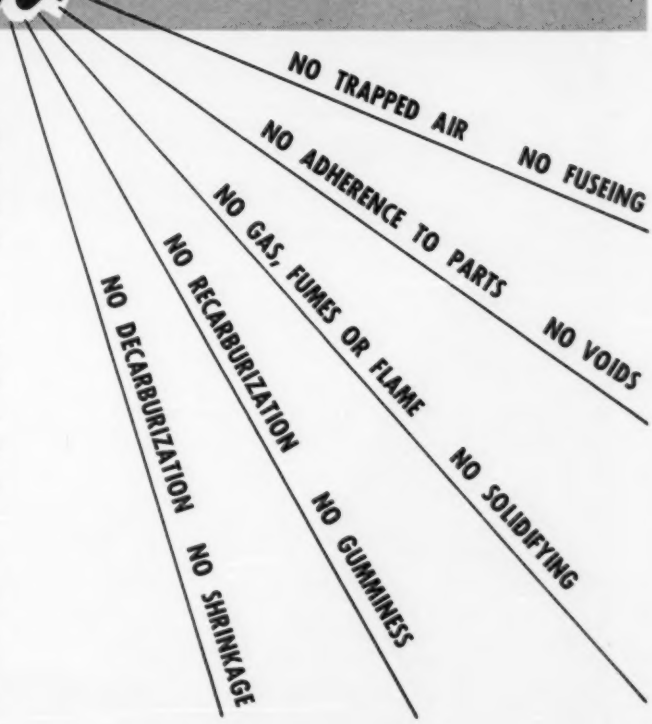
Anneel-Pak is a stable, especially compounded material used successfully for many years in pack hardening and box annealing.

Users are enthusiastic about the many unique qualities of Anneel-Pak—it compacts well, is graphite-free and fast-flowing at 2100°F. *Can be used over and over.*

Anneel-Pak is manufactured by a leading supplier of metallurgical specialties, established in 1916. Expanded facilities now allow increased production.

If you have not yet used Anneel-Pak, a trial 100 lb. drum is offered at the bulk price of 17c lb. Try stable, reliable Anneel-Pak—

Used As Received—
No Tempering Required



GRAPHITE FREE!

BARIUM & CHEMICALS, INC.
WILLOUGHBY, OHIO

USE THIS HANDY COUPON.

BARIUM AND CHEMICALS, INC., WILLOUGHBY, OHIO

Gentlemen:

Ship to the below address, via _____

ONE ☐ 100 lb. package of Anneel-Pak @ .17c per lb

Company Name _____ Our Order Number _____

Address _____

City _____ State _____

Address Material To _____ Title _____

For further information circle No. 58

NEWS TO HEAT TREATERS

(Continued from page 39)

available, the meter is a valuable tool in plant and field inspection, and in the metallurgical laboratory.

Measurements are made on any flat surface 5/8" in diameter or larger, even when surface is rough, dirty, or covered with layers of paint. Measurements are made in about 3 seconds by touching a hand-held probe to the surface tested.

The probe radiates an electro-magnetic field which excites eddy currents in the test part. Instrument response to conductivity and permeability is displayed on a meter, and by two alarm lights. The alarm lights signal conditions above and below pre-set tolerance levels, and hence speed the sorting of parts. Special probes can be supplied for testing curved surfaces.

For further information circle No. 7

MAINTENANCE-COATING OF INDUCTION HEATING WORK-COILS

Induction Heating Corporation of Brooklyn, New York, one of the largest producers of Ther-Monic electronic heat-treating equipment for brazing, melting, annealing,

forging and hardening have just introduced another new product, called "Kotacoil", which the firm recommends for maintenance-coating of all work coils used in induction heating equipment.

The coating is said to assure longer life for work-coils treated with it, and to offer improved efficiency and greater utility of the equipment itself. It prevents troublesome chemical deterioration, such as erosion resulting from association with fluxes, and the like. It also reduces to an absolute minimum the possibility of arcing, as in brazing and hardening applications or from condensation.

For further information circle No. 8

REFRIGERATION CABINET

A fully automatic, low-temperature, refrigeration cabinet has been introduced by Everlast Refrigeration Company, Brooklyn, New

(Continued on page 48)

now a

ROTATING BURNER

for CINCINNATI flamatic® Flame Heating Machines!

- **flame head spins within the area of the part to be heated**
- **simplifies spin hardening of parts difficult to rotate—eliminates expensive fixtures**
- **cuts hardening costs all around**

This newest development of the Meta-Dynamics Division Heat Treating Laboratories brings lower costs to precision selective flame heating of a wide range of parts, because the flame head rotates—*not* the work. The gas-tight rotating joint of the burner has undergone more than 1000 hours of test, with no sign of leakage.

The rotating burner and workholding fixture mount on the flat bed of the basic machine, which contains a quench tank and part removal conveyor. Automatic timing, temperature and quenching control are provided. A separate control cabinet provides accurate control of gas, oxygen, air and water. Other "building blocks" (flame heads and fixtures) are available for such work as brazing and spot, spin, progressive and combination spin-progressive hardening.

For your heat processing work, look to the Cincinnati Flamatic for lowest cost flame heating . . . and the Cincinnati Inductron (built in 15, 30, 50 KW capacities) for lowest cost induction heating. Call in a Meta-Dynamics Division field engineer for full details.

TYPICAL PARTS SUCCESSFULLY HARDENED BY THE FLAMATIC ROTATING BURNER

INTERNAL THREAD of steering knuckle control arm, a pearlitic malleable casting, hardened to Rc 58-60. I.D. is 1¾"; thread length, 1⅛"; overall part length, 22½".

INTERNAL TEETH of SAE 1052 Ring Gear, hardened to Rc 58-60. Gear I.D. is 5¼"; tooth face, ⅝".

inductron flamatic
hardening machines

META-DYNAMICS DIVISION
Machines for Metal Forming and Heat Treating

THE CINCINNATI MILLING MACHINE CO.
Cincinnati 9, Ohio, U.S.A.

CINCINNATI

(Continued from page 40)

to allow for the loss in fluidity. Provision should be made to provide complete drainage of the brazing flux, otherwise hot water and acid neutralizer washes will be ineffective. If flux is trapped inside the joint, there is no harm to the aluminum assembly as long as the joint remains perfectly sealed. However, if moisture reaches the trapped flux, serious corrosion will take place. When using a tool or fixture for support of an aluminum assembly, it is necessary to consider the relation in thermal expansion between its metal and aluminum. Since the expansion of aluminum is greater than that of most metals, distortion will take place in the aluminum components if they are held tightly in place. This is eliminated in two ways:

1) Stainless steel springs (Type 302) are used throughout the fixture with enough pressure exerted to hold the unit but permitting it to expand without distortion during the preheating and brazing operation.

Fig. 7—Fixture assemblies ready for dip brazing.

2) The assemblies can be held in place by tack welding, riveting, spot welding, staking, screws, spring clips, etc.

As a final precaution, it is advisable to construct all fixtures from Inconel® X, Inconel, or nickel. Copper or brass should never be used in an aluminum dip brazing furnace.

A typical procedure for the preparation of an assembly is as follows:

1) Deburr and file machined or ground edges.

2) Degrease all component parts.

3) Clean in 5% sodium hydroxide solution for 20 seconds at 65°C (150°F) or 2 minutes at room temperature.

4) Cold water rinse.

5) Acid dip in (30-40% by weight) nitric acid for 30 seconds.

6) Cold water rinse.

7) Assemble all component parts within 48 hours after cleaning.

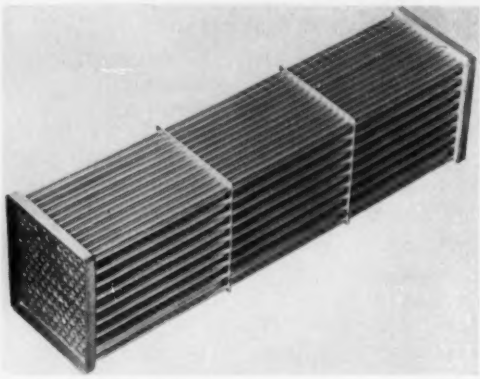


Fig. 8—Intricate aluminum assembly of many components dip brazed in a single operation.

Fig. 6 shows components and Fig. 7 the assemblies loaded on a fixture ready to braze. A typical aluminum brazing cycle will be as follows:

1) Preheat assembly in a circulating air oven to 530°C (1000°F).

2) Immerse directly in brazing bath operating at predetermined temperature within the range 550°C (1030°F) to 640°C (1190°F).

3) Carefully raise the assembly above the bath and allow to drain for 5 to 10 seconds.

4) Quench into water (Hot is preferred for a more thorough removal of the flux salt.).

5) Hot water rinse 80 to 90°C (160-180°F).

6) Acid dip for surface preservation either of *a*), *b*) or *c*) below:

a) Nitric acid bath (30-40%) at room temperature for 10 to 15 minutes.

b) A 1½% hydrofluoric acid bath at room temperature for 5 to 10 minutes followed by a rinse in nitric acid (30-40%) for 2 minutes.

c) A nitric acid-sodium dichromate bath at 150°F for 5 to 10 minutes.

7) Cold water rinse thoroughly.

8) Dry.

In water quenching assemblies from the brazing operation, sufficient time must be allowed prior to quenching for the aluminum alloy to solidify. Otherwise, the alloy will be blown out by the explosive release of steam. Additional time may be desirable to minimize excessive distortion due to thermal stresses where light and heavy sections are involved.

(Continued on page 56)

AUGUST—Selected supplier of anhydrous ammonia . . . assuming that service included technical advice "during use".

LATER—Ammonia system installed without supervision . . . not tested by supplier . . . some parts not designed for ammonia use.

STILL LATER—Had improper atmosphere mixture . . . undesirable case properties . . . sooting and added handling of "finished" parts.

TOO LATE—Too many rejects . . . supplier unable to aid on application. Labor, material and operating costs up . . . profits down.

BE TROUBLE-FREE! Buy your ammonia from Armour. And receive expert technical service—whenever you need it —at no added cost.

Ammonia Sales

ARMOUR INDUSTRIAL CHEMICAL COMPANY

DIVISION OF ARMOUR AND COMPANY
110 NORTH WACKER DRIVE • CHICAGO 6, ILLINOIS

Serving industry for more than half a century with the purest ammonia money can buy.

For further information circle No. 55

HEAT TREATING HINTS

(Continued from page 14)

centage martensite existing at any lower temperature have been reported in the literature. Ms and Mf temperatures for the more commonly used grades of steel have been published in table form in books on metallurgy and in the publications of many steel manufacturers.

A knowledge of the Ms-Mf temperatures is second in importance only to a knowledge of the transformation characteristics above the Ms temperature for any given steel. For if a steel is not cooled rapidly enough through the "nose" or "knee" of the "S" curve during quenching, martensite will not form upon subsequent cooling through the temperature range of martensite formation.

The following illustrates the practical application of Ms-Mf temperatures to the heat treatment of steel. These illustrations assume that the steel being treated has been quenched rapidly enough to avoid the formation of intermediate transformation products such as ferrite, pearlite or Bainite at least at the surface of the workpiece.

1) Ms-Mf temperature data enable the heat treater to establish safer quenching techniques. For example, if the Mf temperature of a steel being treated is 400°F, there is generally no necessity for cooling it to a lower temperature in the quenching operation since the transformation to martensite is complete at that temperature. Quenching stresses and cracking hazards are minimized accordingly.

2) Knowledge of Ms-Mf temperatures enables the heat treater to set up more effective tempering cycles. Residual stresses are minimized and a greater degree of dimensional stability results when a steel is tempered after the transformation to martensite is complete.

3) Martempering or marquenching procedures for a given steel can be more accurately established when the Ms-Mf temperatures are known. This is particularly important in the martempering or marquenching of carburized work since the case will have a different temperature range of martensite formation than will the core. In martempering, the temperature of the quenching bath should be maintained at or slightly above the Ms temperature of the steel being treated if the full benefits of this treatment are to be realized. Less distortion and minimized cracking hazards and residual stresses are among the benefits of martempering or marquenching.

4) Straightening operations can be carried out with a greater degree of safety when Ms-Mf temperatures are known. Straightening operations are most easily performed above the Ms temperature and should be completed before the Mf temperature is reached (applicable principally to steels used at high hardness, above about 45-50 Rc).

Source: HEAT TREATING HINTS
Lindberg Engineering Company

NEWS TO HEAT TREATERS

(Continued from page 42)

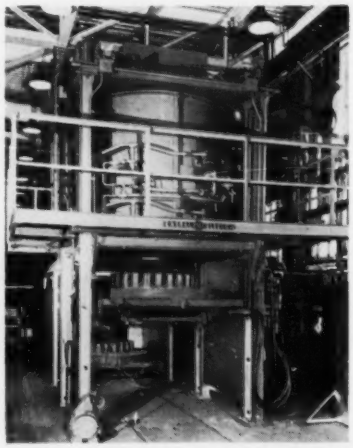
York, for laboratory testing, precision tools, seasoning gauges, and shrink fits, as well as for storage of medical products. The unit is dependable, compact, and economical.

38" wide x 38" deep x 38" high, the storage compartment is 1½ cu. ft. The unit is constructed of superduty steel, insulated with fibre-glass bats and is completely vapor proof; doors are special hard rubber double lid type.

For further information circle No. 9

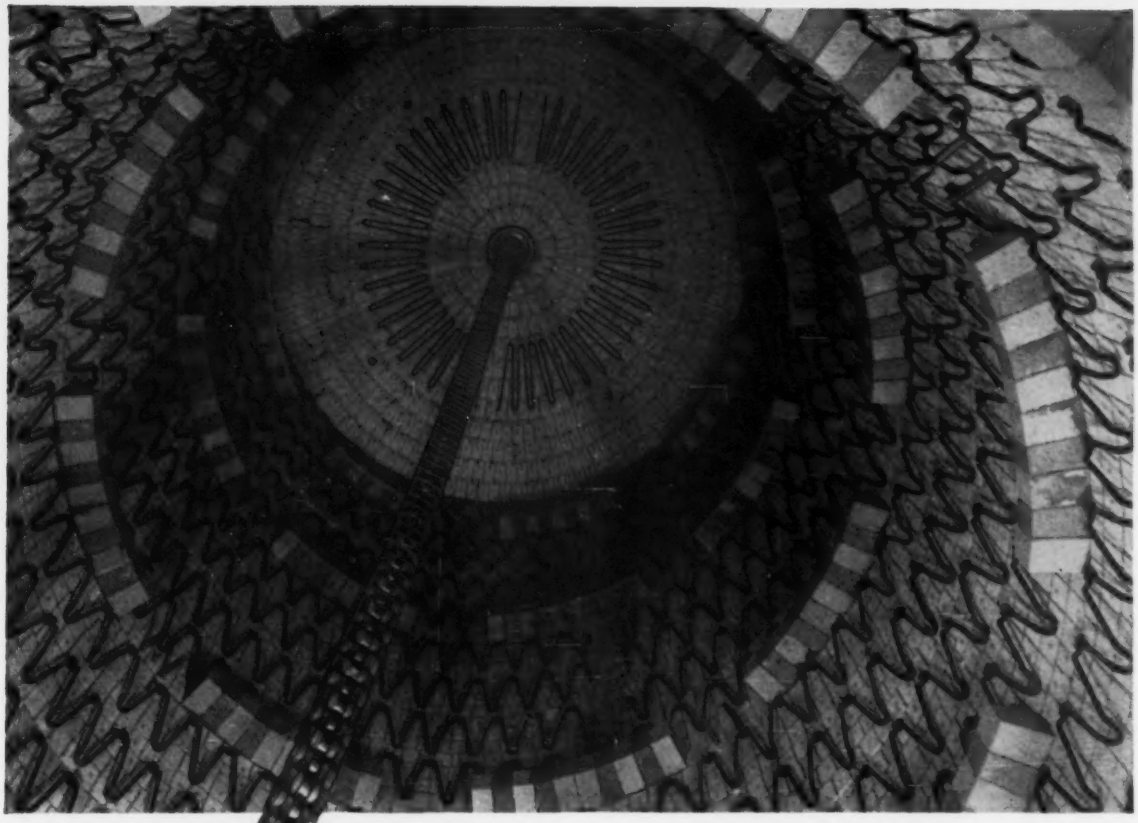
GAS-FIRED BRAZING FURNACE

A new, high-temperature, gas-fired brazing furnace with temperatures up to 2150° F has been installed by General Electric's Small Aircraft Engine Dept., Lynn, Mass., for heat treating its T58 and J85 engine components. Besides nozzle diaphragms, it can treat ring seals and fuel diaphragms.



In addition to high-temperature brazing, the atmospherically-con-

(Continued on page 50)



Inside giant new hardening furnace...

Inconel* alloy chain resists thermal shock, gives lift to rocket production

This chain has two jobs . . . both difficult, both vital to priority production of the Minuteman missile.

First job: — position and hold fuselage components and rocket motor cases during hardening. In this action, the chain (working through a hole in the roof of the giant, controlled-atmosphere, furnace) lifts work from charging pit into shell and secures it. During treatment, chain is outside chamber and hence remains at or near room temperature . . . but wear is a problem since lubricants can't be used.

Second job: — position and hold work pieces in salt and hot water tanks during quenching and rinsing. During these operations, the chain is plunged from air at room temperature into a controlled atmosphere at 2000°F or so. Within minutes this action is reversed. Thermal shock and mechanical stress are both high. The chain must contend, as well, with corrosive attack by furnace atmospheres and by quench and rinse media.

Inconel alloy gives chain the needed reliability

Knowing what metal failure in this chain could do to work, to furnace and to ICBM production, designers at Lindberg Engineering Company, carefully reviewed all candidate metals.

They selected Inconel nickel-chromium alloy. Inconel alloy has an unmatched record for life and strength and corrosion resistance at temperatures in the 2000°F range . . . for resistance to thermal shock, too.

And, with Inconel, the pins and stamped laminations needed for the chain linkage could be readily formed. No hidden defects to cause trouble.

Information is easy to get

For information on Inconel alloy . . . properties, price, delivery, contact your Inco Nickel Alloy distributor . . . listed under "Nickel" in your classified telephone directory.

*Inco trademark

HUNTINGTON ALLOY PRODUCTS DIVISION
The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

INCONEL®

NEWS TO HEAT TREATERS

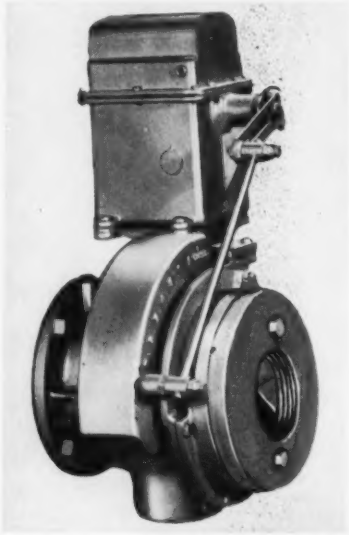
(Continued from page 48)

trolled furnace can be used for bright annealing. It is said that distortion from individual welding of engine parts is eliminated by brazing. It is rated 1,500,000 B.T.U.

For further information circle No. 10

AIR-GAS PROPORTIONING VALVES

A new line of Varitrols (air-gas proportioning valves) for either manual or automatic operation is announced by Eclipse Fuel Engineering Company, Rockford, Illinois. Five sizes are available.



They are designed to provide an economical two-in-one valve method of controlling air and gas to provide the proper blending required for any firing condition. Not only does their use permit a proper setting for any firing condition without the trial-and-error adjustments that would be required with a two-valve setup, but absolute repeatability is also claimed. Returning the control arm to any position, whether manually or automatically, insures an air-gas mixture identical with previous settings.

For further information circle No. 11

INDUSTRIAL FURNACE STATISTICS

During the month of August 1959 industrial furnace manufacturers received orders totaling $9,738,000 up 176% from the $3,533,000 volume in August 1958.

Total net orders for industrial furnaces in the first eight months of 1959 amounted to $66,924,000 up 153% from $26,504,000 level attained in the same period 1958.

Net new orders for induction heating equipment in August 1959 amounted to $1,283,000 up 231% from the August 1958 volume of $383,000. During the period January through August 1959 volume of orders totaled $10,619,000 as compared to $3,791,000 in the same 1958 period, a rise of 180%.

HEAT TREATING AND THE TOOL ENGINEER

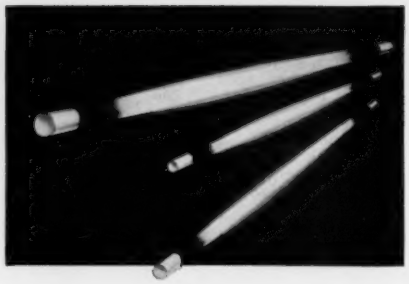
Importance of human engineering in development of modern automatic production equipment was among topics discussed by the American Society of Tool Engineers at its Semiannual Meeting in St. Louis, held October 7-10. Wayne Ewing of Los Angeles, president of ASTE, in announcing the program said: "accelerated progress in metalworking equipment design underlines the continued necessity of emphasizing human factors still involved in production of goods."

Other sessions of the meeting stressed the individual's importance in proper use of modern techniques in numerical control, electronic test equipment, machine tools, metal cutting and heat treating. The latter was co-sponsored by The Metal Treating Institute, New Rochelle, N. Y., and featured two technical papers: "Special Heat-Treat Techniques—Some Case Histories" by Julius Turk, Metallurgist, Paulo Products Company, St. Louis, Missouri; and "The Heat-Treatment of Tools, Jigs and Fixtures" by Edward J. Pavesic, Field Metallurgist, Lindberg Steel Treating Company, Melrose Park, Illinois.

NEW SALES MANAGER

J. H. Werner was named Sales Manager of Lee Wilson Engineering Company, Inc., Cleveland, Ohio, it was announced by C. F. Olmstead, President. Formerly Assistant Sales Manager, Mr. Werner will take over duties previously handled by J. L. Whitten, Vice

(Continued on page 54)



Norton CRYSTOLON Heating Elements or "HOT RODS" are a typical Norton R_{x} — an expertly engineered product prescription for greater efficiency and economy in electric furnace and kiln operations. These one-piece rods, made of self-bonded silicon carbide, have a central hot zone and cold ends. Aluminum-sprayed tips and metal-impregnated ends minimize resistance and power loss. Available in all standard sizes.

Leading manufacturer of masonry bits

Gets twice as much life — and more!

. . . from Norton "HOT RODS"

Operator at New England Carbide Tool Company, Medford, Mass. loads masonry bits into C. I. Hayes Electric Furnace which brazes carbide tips to the shanks of the bits. Norton "HOT RODS" are used exclusively in this furnace because of their longer life and constant heat control characteristics.

Continuous operation in a hydrogen atmosphere at 2250°F is a tough assignment for *any* electric furnace heating element. But Norton CRYSTOLON* Heating Elements ("Hot Rods") take it in stride at New England Carbide Tool Company, world's only manufacturer of a complete line of carbide-tipped masonry bits.

In fact, the company has proved by actual performance that Norton "HOT RODS" last more than twice as long as any other type of non-metallic heating element. What's more, they find that Norton "HOT RODS" make possible smoother, more economical control of power to the furnace during this critical brazing operation.

Norton "HOT RODS" are outlasting other heating elements of the same type in plants everywhere . . . providing better control of heat . . . protecting quality at critical stages of production . . . keeping element costs and maintenance at a new low.

Put Norton "HOT RODS" to work in your heat treating and metalworking operations. They're available in lengths from 6 inches to 8 feet to meet a wide variety of heating requirements efficiently and economically. Get complete details. Send for "Norton Heating Elements". NORTON COMPANY, Refractories Division, 628 New Bond Street, Worcester 6, Mass.

*Trade-Mark Reg. U.S. Pat. Off. and Foreign Countries

NORTON
REFRACTORIES
Engineered . . . R_{x} . . . Prescribed

Making better products . . . to make your products better

NORTON PRODUCTS Abrasives • Grinding Wheels • Grinding Machines • Refractories • Electrochemicals — **BEHR-MANNING DIVISION** Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

(Continued from page 20)

spots and excessive distortion. There were problems too in treating sprockets with large bores in relation to pitch diameters.

One change was the use of heavy copper and then steel plates to support these sprockets and carry heat away from the outer margins. Also, heavy spacers were inserted between parts.

It wasn't until spin quenching was installed that the process really began to hum. This was done by a separate ½" electric drill equipped with a flexible shaft.

Even though the use of plates, spacers and spin quenching improved efficiency greatly, the need for two operators kept costs up.

Ajax designed a new fixture—one that would support, rotate, lower, raise, level and convey a mandrel. It had to be loaded, unloaded and controlled through a wide range of speeds.

The new fixture boosted the number of parts handled in a single cycle and cut the number of operators to one, all in one sweep. Also, sprocket-hardening costs were cut by 75 per cent.

But that's not the only saving from the new setup. Bull gears, previously farmed out, had been hardened by induction techniques. With the old A frame these gears were treated at a saving of 70 cents per part. With the new fixture, per part costs dropped another 61 cents.

One case history proves its success. It concerns the hardening of a 1615 lb. bull gear. After the huge part is carburized in a pit type furnace to a 0.185-0.200" case depth, it's liquid flame hardened in the salt bath furnace.

Of course, Chain Belt built a special fixture to handle the gear. Three torches preheated the part. And total cycle time was 55 minutes. It was also dip quenched to 60 Rc.

Source: THE IRON AGE
September 10, 1959

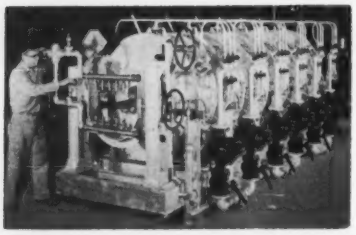
NEWS TO HEAT TREATERS

(Continued from page 51)

President, who will now devote more of his time to company policy.

ANNEALING FURNACE

Three strands of stainless steel tubing are simultaneously annealed in this continuous, automated furnace line designed and built by



Selas Corporation of America, Dresher, Pa.

The six-barrel-furnace line, only 15½' in overall length, can accommodate tubing from ⅝" to 5" O.D. Rated production is 1985 lbs. per hr. (based on 2" O.D. tubing at 3.72 fpm). Automatic temperature control is in three zones, to deliver tubing at 2100°F to the quench located at discharge end. Each barrel unit is equipped with five gas-fired Duradiant burners.

For further information circle No. 12

TUBE FURNACES

It is claimed that temperatures up to 5000° F can be reached in two hours and uniformly maintained throughout the heated length of the Hevi-Duty carbon-resistor tube furnaces, available in 6 standard sizes ranging from 1" x 12" to 5" x 48"

(dimensions refer to internal heated length). Close control and regulation of furnace temperatures are assured by use of a fully automatic saturable reactor control system.

This item on "Tube Furnaces" was run in the July-August issue but it was illustrated with an incorrect picture. The above illustration is correct, and we are sorry for any inconvenience which this error might have caused.

For further information circle No. 13

STRIPPING ANODIZED COATINGS

Heatbath Corporation introduces two new dry powdered products known as Stripal #4 and #5 for use in stripping anodized and oxide coatings from aluminum. Although they are used for the same purpose, Stripal #4 and #5 are very different. Stripal #5 is an alkaline powder that can be used in a steel container at 2 lbs. per gallon without heat to give a rapid stripping of anodized or oxide coatings from aluminum. Stripal #4 is an acid powder used at 1 lb. per gallon at a temperature of 180°-190°F for removing anodic coatings leaving the aluminum bright and free from smut. Both Stripal #4 and #5 contain incorporated inhibitors for preventing attack on the underlying aluminum.

These materials are said to be excellent for use in stripping anodized coatings from racks and rejected parts.

For further information circle No. 14

PACK HARDENING COMPOUND

An especially compounded material used for many years in pack hardening and box annealing is now being offered at special bulk price rates.

Called "Anneel-Pak," the material is said to compact well, to be graphite-free and fast-flowing, even at 2100°F.

A trial 100-lb. drum is offered at a special bulk price.

For further information circle No. 15

(Continued on page 58)

LETTERS TO THE EDITOR

Dear Sir:

Will you please place us on your list for distribution of your magazine "Metal Treating".

We feel it would be a valuable addition to the periodicals in our Plant Technical Library.

Leland Wool
Training Specialist
Convair
San Diego, California

Dear Sirs:

I am a heat treater working at the A. O. Smith Corp. in Milwaukee. Our department receives your publication "Metal Treating," but I don't get much of a chance to read it thoroughly at work and would like my own file for research.

Would it be possible to subscribe to your magazine? It has been very helpful in my work.

Brandon B. Bar Bee
A. O. Smith Corp.
Milwaukee, Wisconsin

Gentlemen:

We would greatly appreciate being put on your mailing list to receive "Metal Treating." We feel that this publication would be of much value to our Metallurgical Engineering Department staff and students.

William F. Mayles
Library Assistant
Case Institute of Technology
Cleveland, Ohio

Gentlemen:

Your periodical "Metal Treating" has been helpful in the heat treatment of high strength metals.

Please place my name on your mailing list to receive future issues.

J. H. Mainhardt
Mfg. Research Group Engineer
Manufacturing Research & Processes Department
Republic Aviation Corporation
Farmingdale, N. Y.

Gentlemen:

The November-December issue of *Metal Treating* addressed to the Engineering Library, Columbia University, has just been brought to my attention. We would greatly appreciate being placed on the mailing list to continue receiving this journal, if that is possible. It will be catalogued for permanent retention in our library.

Russell Shank,
Engineering Librarian
Columbia University,
New York City

Dear Sirs:

I have read a copy of "Metal Treating" recently, and found it to be very informative. I am serving an apprenticeship in heat treating; your magazine will be extremely beneficial to me. Please place my name on the mailing list.

Edward R. Yates
Heat Treat Apprentice 1/c
Norfolk, Va.

Dear Sir:

I have recently had the opportunity to read "Metal Treating", and was very interested in the material it contained.

Please advise me if I may receive a regular copy of this magazine.

Howard A. Brailey
High Voltage Engineering Corp.
Burlington, Mass.

DIP BRAZING

(Continued from page 44)

Typical aluminum brazed assemblies include heat exchangers, wave guides, electronic components such as radar antennae, aircraft parts, etc. Fig. 8 shows the ability to simultaneously braze many joints.

Magnesium brazing is still in a development stage. Although a magnesium alloy with 1.5% manganese was successfully brazed over ten years ago, the first commercial brazing installation has just recently occurred. This material, in alloy form, has low solidus temperatures and partial freezing occurs over a wide range of temperatures. Suitable filler materials are likewise limited.

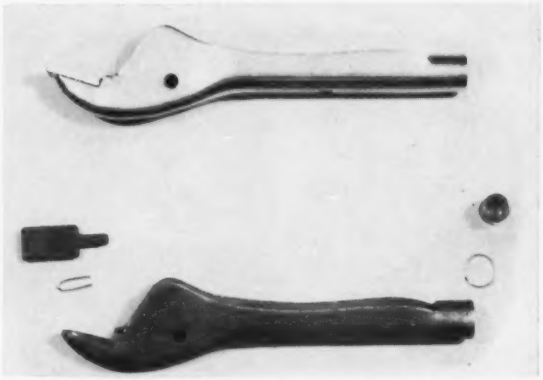


Fig. 9—Components and assembly of special type clamping pliers carburized, brass brazed and hardened in a single operation.

There has been some data published on magnesium brazing, and from this the following general comments can be made:

There are at least two alloys recommended by the Dow Chemical Company, the principal magnesium producer in the United States: namely their No. 171 A and AZ 31 B with filler material AZ 125, and brazing flux No. 425, operating in the range of 590°C (1080°F) and 605°C (1120°F). It appears that the practice to follow resembles closely that outlined for aluminum alloys and consists of the following.

Preparation of specimens:

1) Deburr
2) Degrease
3) Sand lightly or clean electrolytically
4) Wash in hot water, rinse and dry.

Joint clearances will generally be on the generous side—.004" to .006", since the magnesium filler alloys are more viscous than the aluminum filler alloys. It is desirable to locate the filler material internally to the joint because of its tendency to float in the flux, due to its very low density. As usual, the assembly should preferably be self-supporting.

The brazing cycle will follow the general lines outlined below:

1) Preheat in circulating air oven at 850°F-900°F for approximately 3 minutes.
2) Dip braze—AZ 31 B at 1080°-1100°F. M 1 A

at 1100-1120°F. Immersion time is approximately 1 to 2 minutes for sections up to ¼" thick. Time should be held to a minimum to avoid diffusion.

3) Air cool to 600°F.
4) Quench into hot water.
5) Hot water wash and wire brush.
6) Pickle in Dow 1 for 1 minute.
7) Dip into 5% sodium dichromate and bail for 5 minutes.

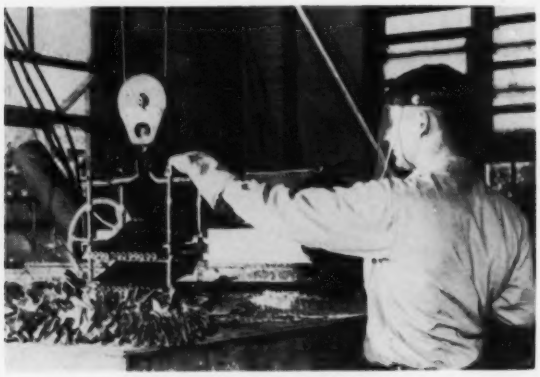


Fig. 10—Installation showing combination carburizing brazing of clamping pliers. Work shown on left of furnace is carburized only.

Lap joints will support 14,000 psi. Pressure tests at 35 psi show that less than 0.25% leak. Figs. 9 and 10 illustrate some applications mentioned above.

The dip brazing process is not new, but its commercial application is more recent than some competitive processes. Like all methods, it has limitations as well as advantages, and its selection, therefore, must be based on a careful evaluation of many factors. It has, however, clearly demonstrated that it can be a practical and economical procedure. It will not do all jobs, but it will do some exceedingly well. • • •

"YES MA'M! - THAT'S THE LARGEST POT ON RECORD!"

NEWS TO HEAT TREATERS

(Continued from page 54)

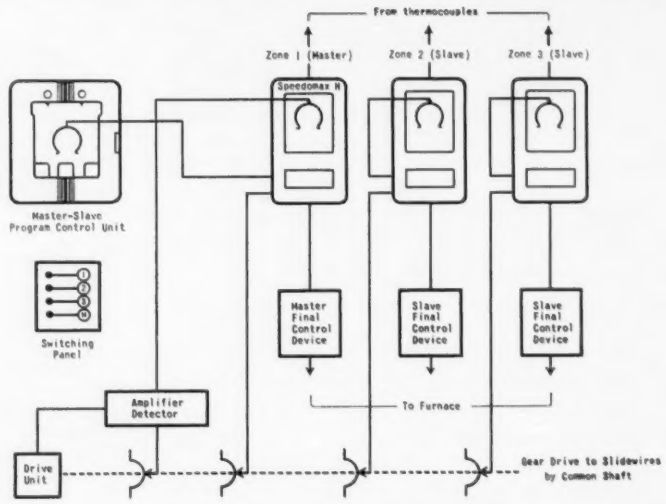
TEMPERATURE CONTROL SYSTEM EXHIBIT

Leeds & Northrup Company, Philadelphia, will unveil its new Master-Slave Program Control System at the National Metals Exposition in Chicago, Ill.

Designed for applications where temperature uniformity is of prime importance, the system already is being used successfully in the brazing of stainless steel honeycomb panels for supersonic aircraft and missiles, where fabricating requires close control over every product phase, and actual brazing temperatures must be held within ±5° or ±10°F during the brazing cycle. (See photo).

Visitors at the show will have an opportunity to simulate a program with the L & N system on display. It will consist of three Speedomax H recorder-controllers with appropriate thermocouples and control devices for each of three zones; a Master-Slave Program Control Unit with its associated Master Drive Unit for automatically and continuously adjusting control point setting for each zone; and a switching panel for selecting any one zone as the master. Process data sheets give further information.

For further information circle No. 16



MASTER-SLAVE PROGRAM CONTROL SYSTEM

VIBRATORY FEEDERS

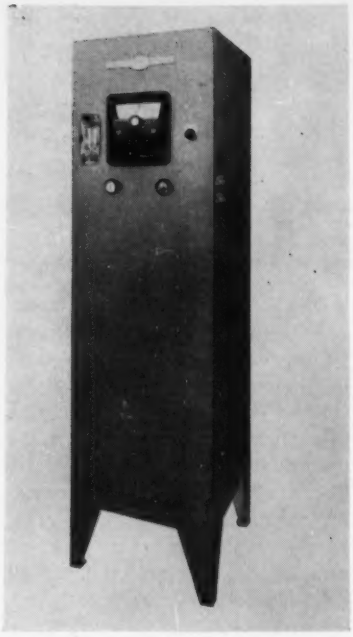
Recently a new cost-reducing application of electromagnetic vibratory feeders has been developed by the Syntron Company. These feeders are said to accomplish efficient, rate-controlled feeding of bulk parts.

Dependable movement of the parts is achieved by the electromagnet drive which produces 3600 smooth vibrations a minute. The vibrations are effectively controlled by an easily-operated rheostat in the feeder's separate controller, permitting accurate adjustment of vibration to the best flow characteristics of the parts being fed, and regulation of feed rate.

For further information circle No. 17

ENDOTHERMIC GENERATOR

Design features which permit more accurate control of gas-to-air ratio, retort chamber temperature, "Carbon Pressure," and low dew point have been incorporated into



the proven Type IGL Generators manufactured by C. I. Hayes, Inc., of Cranston, R. I.

These generators use a mixture of air and natural gas, propane, or manufactured gas to deliver precisely controlled, medium or high carbon-potential protective atmospheres for heat treating the more difficult and complex steels, carbonitriding mild steels, and for controlled-sintering operations.

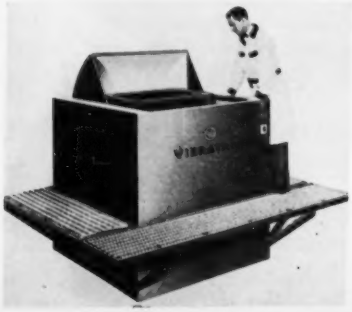
For further information circle No. 18

DESCALING AND DEBURRING MACHINE

The Vibratron, a newly-developed machine for mass production cleaning, descaling, deburring, radiusing, fine finishing, and coloring of metal parts has been introduced by the Roto-Finish Co., Kalamazoo, Michigan.

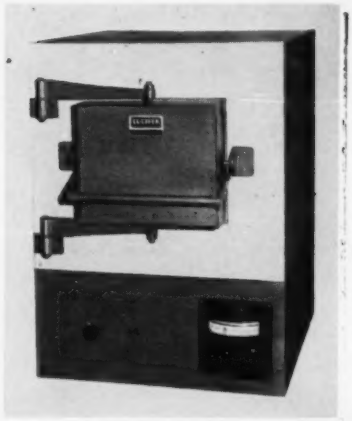
Complex cast, forged, stamped, and machined parts with shielded and internal surfaces are conveniently finished in the new machine. Time cycles are very short with a rate of production claimed up to 1000% greater than parts processed utilizing conventional barrel finishing techniques. The process is claimed to be very economical inasmuch as only a few ounces of compound are necessary to do an effective job.

For further information circle No. 19



HIGH TEMPERATURE FURNACE

A new model has been added to the line of Lucifer Furnaces, Inc. standard production models of heat treating furnaces. This model is of box-type construction and includes elements with heat ranges to 3190°F.



The new series includes seven models in box or tube design. All furnaces are complete and include automatic controllers (indicating and controlling), platinum-rhodium thermocouples, magnetic contractors, high-temperature elements, terminals, aluminum strips for terminal connections, selector switches, and element transformers.

For further information circle No. 20

SKIN RASH LOTION

A new invisible protective product against rashes is now available from Vanfaire Co., North Hollywood, Calif., for the industrial worker with hands exposed to chemicals, oils, grease, solvents, plastics, and paint. Applied like any hand lotion, it is soluble in soap and water.

For further information circle No. 21

MANUFACTURERS' LITERATURE

For your copy circle the number on the Readers' Service Card

ALLOY BULLETIN

Rolled Alloys, Inc., Detroit, has completed and released a new bulletin containing the latest information on an important metal, RA309, used extensively where heat or corrosion is a problem. Descriptive charts are given for composition, density, mean coefficient of expansion, melting point range, mechanical properties, creep strength, and stress rupture properties, as well as size ranges, and information on fabrication. All stock forms of the metal are produced to standard specifications.

For further information circle No. 22

QUICK COMPOSITION ANALYSIS

H. W. Dietert Co. has published a 16-page catalog describing their equipment used for rapid, two-minute determination of carbon and sulphur content of metal chips, particles, or pellets, thus securing accurate knowledge of composition before heat treating.

For further information circle No. 23

INDUCTION HEATING MOTOR-GENERATOR

The Safety Electrical Equipment Corporation, Hamden, Conn., has published a bulletin which describes its completely new line of totally-enclosed, water-cooled, inductor-type motor-generator sets. They are specifically designed and produced for the induction heating industry. All units are built in complete conformity with JIC and NEMA standards and are available in all ratings from 50kw up to and including 350kw @ 1000 cycles; 300kw @ 3000 cycles; and 150kw @ 10,000 cycles.

For further information circle No. 24

HEAT TREATING BULLETINS

Sunbeam Equipment Corp., Meadville, Pa., has published several catalog bulletins which describe their line of equipment now that they have purchased the Westinghouse industrial furnace business.

Please circle the item number for the ones in which you are interested on the Readers' Service Card:

Atmosphere Generators — 20-page bulletin describes complete line of protective atmosphere generating equipment including exothermic, endothermic and ammonia dissociator types.

For further information circle No. 25

Bell-type Furnaces—8-page bulletin, describes complete line of gas-fired and electric bell-type furnaces.

For further information circle No. 26

Box-type Electric Furnaces — 12-page bulletin, describes line of box-type electric furnaces.

For further information circle No. 27

Box-type Fuel-Fired Furnaces—12-page bulletin, describes complete line of box-type fuel-fired furnaces.

For further information circle No. 28

Pot-type Furnaces—20-page bulletin, describes complete line of fuel-fired or electric pot-type furnaces.

For further information circle No. 29

INERT ATMOSPHERE GENERATORS

Gas Atmospheres, Inc., Cleveland, has just published a new bulletin describing their new line of packaged inert atmosphere generators. The bulletin includes typical installations, applications, features, and a comprehensive flow chart. It also includes a utilities table showing at a glance the amounts of gas, power, and water required to obtain maximum capacities.

For further information circle No. 30

QUENCH BATH TEMPERATURE

Niagara Blower Company has published several bulletins explaining the operation of its heat exchanger to control the temperature of a quench bath. They maintain that their equipment removes the heat at its rate of input, thus enabling the quenching to be done at the exact temperature that gives the product the best physical properties.

For further information circle No. 31

FIBRE GLASS TANK LINERS

Availability of laminated fibre glass tank liners for the plating and metal finishing industry has been announced by the Myco Company, Inc., Belvidere, Illinois, a recently acquired division of Eclipse Fuel Engineering Co., Rockford, Illinois.

Liners are built to specification of laminated seamless fibre glass and plastic resin formed and set under pressure and heat. Liners are fitted to wooden tank, constructed of plywood, reinforced with structural wood members. Liner extends over the edge and includes a 12" skirting.

For further information circle No. 32

RESEARCH REPORT

A research report based on studies at the Polytechnic Institute of Brooklyn, has been issued by the Committee on Industrial and Commercial Gas Research of the American Gas Association on "The Significance of Waste Heat Recovery Methods to the Gas Industry."

This report summarizes heat recovery equipment now in use and points out that waste heat recovery is applied today not so much to reduce the cost of fuel as to increase production and improve the product.

For further information circle No. 33

NEW SPECIFICATION SHEETS

Specification Sheets describe Fischer & Porter "Mark III" four-inch strip chart miniature recording and recording control stations for process variables.

For further information circle No. 34

NEW HEAT TREATING UNITS

The Facts on the New Ipsen Heat Treating Units is the title of a new 6-page technical bulletin just published by Ipsen Industries, Inc., Rockford, Illinois, manufacturers of industrial heat treating units and related equipment.

Eleven cross-section drawings, photographs and tables give detailed construction and performance facts on the equipment which operates at temperatures up to 2000°F. The units are designed for carburizing, carbon restoration, carbonitriding, neutral hardening, marquenching, normalizing, annealing and brazing.

For further information circle No. 35

HEAT TREATMENT OF TOOL STEELS

A new 28-page technical booklet entitled, "Modern Principles of Heat Treatment of Steel", has just been published by Uddeholm Company of America, Inc.

The booklet describes the derivation and meaning of the TTT diagram and provides fundamental information concerning various heat treating procedures including step-annealing, martempering and austempering. It also includes TTT diagrams for all commonly used grades of SAE tool steels and is liberally illustrated with photomicrographs and charts to clarify the text.

For further information circle No. 36

FREE BOOKLET FOR PROSPECTIVE AUTHORS

A new free 50-page manual, *Writing and Publishing Your Technical Book*, has been published by F. W. Dodge Corporation, New York.

The booklet is written to help authors organize and develop their ideas for books to the point where they can obtain the support and backing of a publisher. It answers a great many questions about the author-publisher relationship and presents many practical checklists for preparing material for publication.

The manual answers many questions which confront would-be authors. Among its chapters are: Should You Write a Book?, Choosing a Publisher, The Prospectus and Outline, Writing the Specimen Chapters, Acceptance and the Contract. A great deal of information about business and technical publishers is included.

For further information circle No. 37

EQUIPMENT AND

AMMONIA, ANHYDROUS

ARMOUR INDUSTRIAL CHEMICAL COMPANY
DIVISION OF ARMOUR AND COMPANY
110 North Wacker Drive
Chicago 6, Illinois

AMMONIA STORAGE EQUIPMENT

ARMOUR INDUSTRIAL CHEMICAL COMPANY
DIVISION OF ARMOUR AND COMPANY
110 North Wacker Drive
Chicago 6, Illinois

C. I. HAYES, INC.
816 Wellington Avenue
Cranston 10, Rhode Island

CARBURIZING COMPOUNDS

PARK CHEMICAL COMPANY
8074 Military Avenue
Detroit 4, Michigan

EVAPORATIVE COOLING

NIAGARA BLOWER COMPANY
405 Lexington Avenue
New York 17, New York

FABRICATION
(Heat & Corrosion Resistant)

ALUMINUM AND ARCHITECTURAL
METALS COMPANY
1974 Franklin Street
Detroit 7, Michigan

BERLIN CHAPMAN CO.
Berlin, Wisconsin

GENERAL ALLOYS COMPANY
390 West First Street
Boston 27, Massachusetts

IPSEN INDUSTRIES, INC.
715 South Main Street
Rockford, Illinois

ROLOCK, INC.
1232 Kings Highway
Fairfield, Connecticut

STANWOOD CORPORATION
4825 West Cortland Street
Chicago 39, Illinois

WIRETEX MFG. CO., INC.
16 Mason Street
Bridgeport 5, Connecticut

FIXTURES

AJAX ELECTRIC COMPANY
940 Frankford Avenue
Philadelphia 23, Pennsylvania

ALUMINUM AND ARCHITECTURAL
METALS COMPANY
1974 Franklin Street
Detroit 7, Michigan

BERLIN CHAPMAN CO.
Berlin, Wisconsin

GENERAL ALLOYS COMPANY
390 West First Street
Boston 27, Massachusetts

INTERNATIONAL NICKEL CO., INC
67 Wall Street
New York 5, New York

RANDOLPH LABORATORIES, INC.
1454 Frontage Road
Northbrook, Illinois

ROLLED ALLOYS, INC.
South River, New Jersey

ROLOCK, INC.
1232 Kings Highway
Fairfield, Connecticut

STANWOOD CORPORATION
4825 West Cortland Street
Chicago 39, Illinois

WIRETEX MFG. CO., INC.
16 Mason Street
Bridgeport 5, Connecticut

FLAME HARDENING

META-DYNAMICS DIVISION
THE CINCINNATI MILLING
MACHINE COMPANY
4701 Marburg Avenue
Cincinnati 9, Ohio

SELAS CORPORATION OF AMERICA
Dresher, Pennsylvania

FLOW MEASUREMENT

AMERICAN GAS FURNACE CO.
808 Lafayette Street
Elizabeth, New Jersey

SELAS CORPORATION OF AMERICA
Dresher, Pennsylvania

WAUKEE ENGINEERING CO.
5137 North 35th Street
Milwaukee 9, Wisconsin

FURNACES

AMERICAN GAS FURNACE CO.
808 Lafayette Street
Elizabeth, New Jersey

DENVER FIRE CLAY COMPANY
2301 Blake Street
Denver, Colorado

C. I. HAYES, INC.
816 Wellington Avenue
Cranston 10, Rhode Island

HEVI-DUTY ELECTRIC COMPANY
A DIVISION OF
BASIC PRODUCTS CORPORATION
P. O. Box 563
Milwaukee 1, Wisconsin

CHARLES A. HONES, INC.
Baldwin, L. I., N. Y.

IPSEN INDUSTRIES, INC.
715 South Main Street
Rockford, Illinois

LINDBERG ENGINEERING COMPANY
2466 West Hubbard Street
Chicago 12, Illinois

PACIFIC SCIENTIFIC COMPANY
P. O. Box 22019
Los Angeles 22, California

SELAS CORPORATION OF AMERICA
Dresher, Pennsylvania

FURNACES (Salt Bath)

AJAX ELECTRIC COMPANY
940 Frankford Avenue
Philadelphia 23, Pennsylvania

AMERICAN GAS FURNACE CO.
808 Lafayette Street
Elizabeth, New Jersey

HEVI-DUTY ELECTRIC COMPANY
A DIVISION OF
BASIC PRODUCTS CORPORATION
P. O. Box 563
Milwaukee 1, Wisconsin

CHARLES A. HONES, INC.
Baldwin, L. I., N. Y.

LINDBERG ENGINEERING COMPANY
2466 West Hubbard Street
Chicago 12, Illinois

FURNACES (Vacuum)

C. I. HAYES, INC.
816 Wellington Avenue
Cranston 10, Rhode Island

HEVI-DUTY ELECTRIC COMPANY
A DIVISION OF
BASIC PRODUCTS CORPORATION
P. O. Box 563
Milwaukee 1, Wisconsin

IPSEN INDUSTRIES, INC.
715 South Main Street
Rockford, Illinois

LINDBERG ENGINEERING COMPANY
2466 West Hubbard Street
Chicago 12, Illinois

NEW YORK AIR BRAKE COMPANY
KINNEY MFG. DIVISION
3594 D Washington Street
Boston 30, Massachusetts

PACIFIC SCIENTIFIC COMPANY
P. O. Box 22019
Los Angeles 22, California

MATERIALS DIRECTORY

Metal Treating

THE ONLY MAGAZINE DEVOTED EXCLUSIVELY TO THE HEAT TREATING INDUSTRY

GAS BURNERS & TORCHES

CHARLES A. HONES, INC.
Baldwin, L. I., N. Y.

GAS GENERATORS

AMERICAN GAS FURNACE CO.
808 Lafayette Street
Elizabeth, New Jersey

C. I. HAYES, INC.
816 Wellington Avenue
Cranston 10, Rhode Island

HEVI-DUTY ELECTRIC COMPANY
A DIVISION OF
BASIC PRODUCTS CORPORATION
P. O. Box 563
Milwaukee 1, Wisconsin

IPSEN INDUSTRIES, INC.
715 South Main Street
Rockford, Illinois

LINDBERG ENGINEERING COMPANY
2466 West Hubbard Street
Chicago 12, Illinois

PACIFIC SCIENTIFIC COMPANY
P. O. Box 22019
Los Angeles 22, California

GAS MIXING EQUIPMENT

WAUKEE ENGINEERING CO.
5137 North 35th Street
Milwaukee 9, Wisconsin

GASES

ARMOUR INDUSTRIAL CHEMICAL COMPANY
DIVISION OF ARMOUR AND COMPANY
110 North Wacker Drive
Chicago, Illinois

HARDNESS TESTERS

STEEL CITY TESTING MACHINES, INC.
8805 Lyndon Avenue
Detroit 38, Michigan

WILSON MECHANICAL INSTRUMENT DIV.
AMERICAN CHAIN & CABLE COMPANY, INC.
230 Park Avenue
New York 17, New York

HEAT EXCHANGERS

NIAGARA BLOWER COMPANY
405 Lexington Avenue
New York 17, New York

HEATING ELEMENTS (Non-Metallic)

NORTON COMPANY
622 New Bond Street
Worcester 6, Massachusetts

HIGH TEMPERATURE FANS

GARDEN CITY FAN COMPANY
801 North Eighth Street
Niles, Michigan

INDUCTION HARDENING

META-DYNAMICS DIVISION
THE CINCINNATI MILLING
MACHINE COMPANY
4701 Marburg Avenue
Cincinnati 9, Ohio

METAL FINISHING

HEATBATH CORPORATION
P. O. Box 78
Springfield 1, Massachusetts

PROTECTIVE COATINGS

MARKAL COMPANY
3102 W. Carroll Avenue
Chicago 12, Illinois

PARK CHEMICAL COMPANY
8074 Military Avenue
Detroit 4, Michigan

PARKER-HARTFORD CORPORATION
Hartford, Connecticut

QUENCH BATH TEMPERATURE CONTROLS

NIAGARA BLOWER COMPANY
405 Lexington Avenue
New York 17, New York

QUENCHING OILS

E. F. HOUGHTON & CO.
303 West Lehigh Avenue
Philadelphia 33, Pennsylvania

PARK CHEMICAL COMPANY
8074 Military Avenue
Detroit 4, Michigan

SINCLAIR REFINING COMPANY
600 Fifth Avenue
New York, New York

SUN OIL COMPANY
INDUSTRIAL PRODUCTS DEPARTMENT
Philadelphia 2, Pennsylvania

REFRACTORIES

NORTON COMPANY
622 New Bond Street
Worcester 6, Massachusetts

SALTS (Heat Treating)

AMERICAN CYANAMID COMPANY
PROCESS CHEMICALS DEPARTMENT
30 Rockefeller Plaza
New York 20, New York

BARIUM & CHEMICALS, INC.
Willoughby, Ohio

HEATBATH CORPORATION
P. O. Box 78
Springfield 1, Massachusetts

E. F. HOUGHTON & CO.
303 West Lehigh Avenue
Philadelphia 33, Pennsylvania

PARK CHEMICAL COMPANY
8074 Military Avenue
Detroit 4, Michigan

SPECIAL CONTROL EQUIPMENT

AJAX ELECTRIC COMPANY
940 Frankford Avenue
Philadelphia 23, Pennsylvania

IPSEN INDUSTRIES, INC.
715 South Main Street
Rockford, Illinois

RANDOLPH LABORATORIES, INC.
1454 Frontage Road
Northbrook, Illinois

TEMPERATURE CONTROLS

HARRY W. DIETERT COMPANY
9330 Roselawn
Detroit 4, Michigan

MARKAL COMPANY
3102 West Carroll Avenue
Chicago 12, Illinois

WEST INSTRUMENT CORPORATION
4363 West Montrose
Chicago 41, Illinois

TESTING EQUIPMENT

PACIFIC SCIENTIFIC COMPANY
P. O. Box 22019
Los Angeles 22, California

RIEHLE TESTING MACHINES DIVISION
AMERICAN MACHINE AND METALS, INC.
East Moline, Illinois

STEEL CITY TESTING MACHINES, INC.
8805 Lyndon Avenue
Detroit 38, Michigan

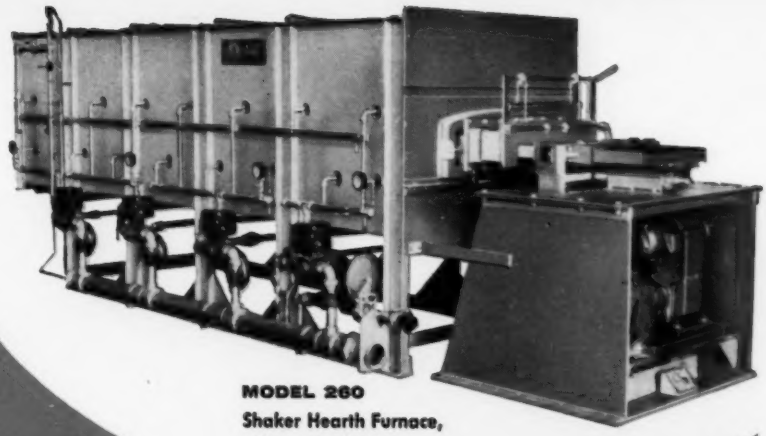
WILSON MECHANICAL INSTRUMENT DIV.
AMERICAN CHAIN & CABLE COMPANY, INC.
230 Park Avenue
New York 17, New York

TOOL STEELS

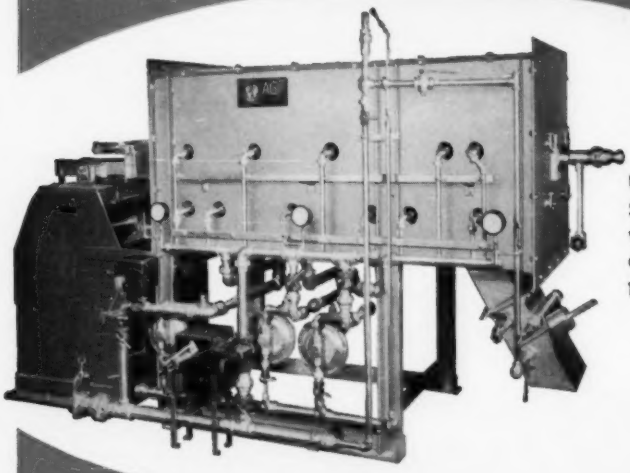
BETHLEHEM STEEL COMPANY
Bethlehem, Pennsylvania

Index To Advertisers

HEAT TREAT SMALL PARTS BEST with AGF'S SHAKER HEARTH FURNACES



MODEL 260
Shaker Hearth Furnace, with a production capacity of 800 lbs. per hour.



81 YEARS OF PIONEERING

MODEL 238-A
Shaker Hearth Furnace, with a production capacity of approximately 150 lbs. per hour.

VERSATILE Complete atmosphere control for heat treating from pen points to forgings, *IN THE SAME FURNACE.*

SIMPLE Complicated maintenance problems are eliminated by the unique method of work conveyance . . . A reciprocating hearth plus a simple mechanical drive.

EFFICIENT No conveyor to drag heat from furnace . . . A CONTINUOUS FURNACE for automatic or manual feeding.

FULL MUFFLE CONSTRUCTION Provides exact control of processing atmosphere . . . Many small burners, in multiple control zones, heat the muffle uniformly.

Shaker Hearths are available with capacities from 25 lbs. per hour to 800 lbs. per hour.

Send for complete data and specification sheets on these and all of the other many "QUALITY BUILT" AGF furnaces for all specific and diversified uses.

AMERICAN GAS FURNACE CO.
808 LAFAYETTE STREET — ELIZABETH 4, N. J.

For further information circle No. 73

Provides any needed quench velocity
"from nothing to NIAGARA"!

beyond doubt...THE MOST VERSATILE QUENCH EVER BUILT!

Here is isothermal quenching control that assures hitting your TTT curve requirements "on the nose" . . . every time . . . time after time . . . on practically any type of work;

- . . . **that has handled all of the critical work shown above—and hundreds of other items besides;**
- . . . **that provides the exact needed quench direction and velocity at the turn of a crank . . . and with available velocities far in excess of any quench previously obtainable;**
- . . . **that does everything oil can do up to 400° F. and that can supply exact needed quench temperatures up to 750° F. *without any fire hazard;***
- . . . **that offers automatic water addition as an optional feature;**
- . . . **that provides a completely automatic separating system to carry off drag-in salt, thus maintaining its exceptional quenching power.**
- . . . **and which, brings you all inherent salt bath advantages such as uniform hardness, elimination of quench cracks and negligible distortion.***

In short, wherever highly accurate, low cost quenching is a problem, chances are 10 to 1 the Ajax Cataract Quench Furnace can solve it!

AJAX HUGREN **Cataract®** **SALT BATH QUENCH**

* **For instance, one user scored a $60,000 yearly saving by eliminating a costly straightening operation on an intricately-shaped machine part.**

AJAX ELECTRIC COMPANY 940 Frankford Avenue, Philadelphia 23, Pa.

(SEE AJAX CATARACT QUENCH ON CLOSED CIRCUIT TV, BOOTH 1526 METAL SHOW)

For further information circle No. 72